ABSTRACTS OF NORTH AMERICAN GEOLOGY

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UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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UNITED STATES DEPARTMENT OF THE INTERIOR

ROGERS C. B. MORTON, *Secretary*

GEOLOGICAL SURVEY

William T. Pecora, *Director*

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ABSTRACTS OF NORTH AMERICAN GEOLOGY

INTRODUCTION

Abstracts of North American Geology contains abstracts of technical papers and books and also citations of maps on the geology of North America including Greenland, the West Indies, as well as the State of Hawaii, Guam, and other island possessions of the United States. Articles of a general nature by North American authors are cited even though published in foreign journals but those by foreign authors are included only if they appear in North American journals. Abstracts are prepared only of material that is believed to be generally available. Ordinarily abstracts are not published of material with small circulation (such as dissertations, open-file reports or memorandums) or of other papers presented orally at meetings.

The Abstracts is an additional reference tool but does not replace the Bibliography of North American Geology, which has been published by the Geological Survey since 1887. Twelve monthly issues of Abstracts of North American Geology are published each year. The Bibliography includes citations and subject index for a calendar year.

The numbers assigned to the abstracts in this publication are for reference in using the index; they are not order numbers. Publications cited here in abstract form are available in most geological libraries or through interlibrary loan.

Abstracts of North American Geology and the Bibliography are prepared by use of computer techniques. Each abstract, along with its indexing, is placed on magnetic tape and entered into a permanent data bank. The material prepared each month is published in the form of the present issue. The abstracts are arranged alphabetically according to senior author. A subject index follows the abstracts and is designed for rapid reference to any subject desired. Bibliographies can subsequently be retrieved according to the terms used in the index.

A list of journals commonly cited in Abstracts of North American Geology may be obtained by writing to the U.S. Geological Survey, Washington, D. C. 20242. Serial publications cited for the first time are as follows:

Am. Zoologist—American Zoologist. A quarterly publication of the American Society of Zoologists. Thousand Oaks, Calif.

Canada Dept. Energy, Mines and Resources, Marine Sci. Br. Paper—Canada Department of Energy, Mines and Resources, Marine Sciences Branch Paper. Ottawa, Ontario, Canada.

Canadian Metall. Quart.—Canadian Metallurgical Quarterly. Canadian journal of metallurgy and materials science. The Metallurgical Society of the Canadian Institute of Mining and Metallurgy. Montreal, Quebec, Canada.

Chem. Commun.—Chemical Communications. Journal of the Chemical Society, Section D. London, England.

Wasser u. Boden—Wasser und Boden. Verlag Wasser und Boden—Axel Lindow and Co. Hamburg, Germany.

The abstracts in this issue were prepared by Fred Barker, Cornelia C. Cameron, William B. Cashion, George V. Cohee, Georgianna D. Conant, Howard R. Cramer, Edwin B. Eckel, John H. Feth, Andrew Griscom, Elizabeth Hambleton, J. E. Harrison, John W. Huddle, Virginia M. Jussen, Elizabeth R. King, Ronald W. Kistler, R. A. Loney, Elisabeth S. Loud, Sergius H. Mamay, Mildred C. Mead, E. A. Merewether Donal R. Millineaux, Virginia S. Neuschel, Earl H. Pampeyan, John C. Reed, Jr., Henry W. Roehler, Edward T. Ruppel, E. G. Sable, Marie Siegrist, Dorothy B. Vitaliano, Holly C. Wagner, Ray E. Wilcox, and R. G. Yates.

ABSTRACTS

04468 **Abel, John F.** Rock mechanics—Can it pay its way?, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 197-207, illus., 1970.

Theoretical elastic analysis and laboratory physical specimen testing can be used to predict rock response to excavation and to indicate potential problem areas. Because of the geological complexity of rock masses, instrumentation must be used to measure the actual response of a rock mass. The greatest potential dollars and cents application today is probably measurement verification of existing mine designs. It is not necessary to accept a room and pillar pattern as the best optimum design. Pillar sizes and roof spans can be tested, changed, and tested again. Effectiveness of support reinforcement as well as its design can be determined. A proper program of rock mechanics serves also to detect impending failure. — *from* Author's abstract

Acar, K. Z. *See* King, M. S. 04470

04574 **Adams, Samuel S.** Ore controls, Carlsbad potash district, southeast New Mexico, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 246-257, illus., 1970.

The potassium mineralization in the Permian Salado Formation is in nine distinct zones in an area of over 3000 sq mi. South of the Capitan reef, rising formation brines have altered the ore zones to secondary K_2SO_4-bearing assemblages or have replaced all K-bearing minerals. K deposition occurred during periods of extreme desiccation attended by basin restriction and peripheral mud flats. One interval of basin subsidence is recognized within the salt zones; the rest of the salt structures are related to K distribution. In the Delaware basin most relations between ore and structures have been obliterated by the metasomatism and dissolution of K mineralization within the ore zones. Salt distribution within the Salado Formation is not obviously related to thickness variations of selected intervals. — *from* Author's abstract

04590 **Addicott, W. O.** Miocene gastropods and biostratigraphy of the Kern River area, California: U.S. Geol. Survey Prof. Paper 642, 174 p., illus., tables, 1970.

Gastropods of 182 taxa, including 49 new (and additional forms yet unnamed), are described from lower and middle Miocene marine strata exposed along Kern River northeast of Bakersfield. Outcrop sections are correlated with subsurface sections of nearby oil wells by molluscan and associated faunas; nomenclatural history of each formation is reviewed. Faunal assemblages from the subsurface Vedder Sand, the overlying exposed Jewett Sand, and cores of the overlying Freeman Silt are referred to the early Miocene "Vaqueros Stage" of Pacific coast megainvertebrate chronology. The lower Jewett contains 46 gastropod taxa, many new, almost half of which do not occur higher in the local section. The exposed Olcese Sand and overlying Round Mountain Silt are referred to the middle Miocene "Temblor Stage"; of 157 gastropod taxa, almost one-third new, about 15 percent are useful index species. — VMJ

04914 **Addie, George G.** The Metaline district, Pend Oreille County, Washington, [Chap.] 6 *in* Lead-zinc deposits in the Kootenay Arc, northeastern Washington and adjacent British Columbia — Soc. Econ. Geologists, 1970 Northwest Field Conf. Guidebook: Washington Div. Mines and Geology Bull. 61, p. 65-78, illus., 1970.

Rocks range in age from Cambrian to Tertiary. The host rock for all important ore bodies is the brecciated zone known as the Josephine horizon at the top of the

Metaline Limestone. It has been considered as hydrothermally metamorphosed Metaline, and as an irregular original unit resulting from sedimentary and erosional processes. Addie considers it to consist of a hanging wall zone and an ore zone. The dominant structure is a wedge-shaped graben. Gash veins in the hanging wall may be tensional features related to Phase II folding. Lead isotopes indicate that leads of different ages are involved. A hydrothermal origin is favored by several geologists, and some remobilization has occurred. — ESL

04915 **Addie, George G.** The Reeves MacDonald mine, Nelway, British Columbia, [Chap.] 7 *in* Lead-zinc deposits in the Kootenay Arc, northeastern Washington and adjacent British Columbia — Soc. Econ. Geologists, 1970 Northwest Field Conf. Guidebook: Washington Div. Mines and Geology Bull. 61, p. 79-88, illus., 1970.

The lead-zinc ore bodies are sulfide replacement deposits in dolomite zones in the Reeves Limestone Member of the Laib Formation. Stratigraphy of the Early Cambrian Quartzite Range, Reno, and Laib Formations is discussed. A reverse fault has brought the older Active Formation into contact with the Laib. The most prominent structural feature is the isoclinal Salmo River anticline. Principal sulfides in the ore are pyrite, sphalerite, and galena. Gash veins filling tension openings are younger than the main ore body. Isotopes indicate that galenas have a complex history. Three genetic hypotheses: hydrothermal, syngenetic, and remobilization are reviewed briefly. Addie suggests a "special facies" control in which syngenetic pyrite is replaced by penesyngenetic sphalerite that was later mobilized to form the present ore bodies. — ESL

05037 **Affleck, James.** Definition of regional structures by magnetics, [Chap.] 1 *in* The megatectonics of continents and oceans (Helgi Johnson and Bennett L. Smith, editors): New Brunswick, N. J., Rutgers Univ. Press, p. 3-11, illus., 1970.

Magnetic anomaly patterns in many areas suggest that major orogenetic welts of various epochs are rejuvenations of stress patterns developed in Precambrian times [Applachians, for example]. There is a strong statistical bias toward dominance of anomaly trends in the N-S, E-W, N-E, and N-W directions in all large magnetic surveys which have been studied. These surveys have revealed E-W magnetic interruptions. The Mendocino fracture of the East Pacific, for example, is thought to cross under the continent into the Atlantic. These patterns all suggest the permanency of the continents, and that the relation of the Earth's spin axis to the crust has been constant since Precambrian time. — Author's summary

04794 **Agashe, Shripad N.; Tilak, S. T.** Occurrence of fungal elements in the bark of arborescent calamite roots from the American Carboniferous: Torrey Bot. Club Bull., v. 97, no. 4, p. 216-218, illus., 1970.

Well-preserved fossil fungal remains, both vegetative and reproductive structures, are described. They were observed in the cortical tissue of arborescent calamite roots [*Astromyelon cauloides* Anderson] in coal balls collected from the Upper Pennsylvanian [McLeansboro Group] near Berryville, Ill. These fungi show close resemblance to the aquatic Phycomycetes such as Peronosporales and Chytridiales. — *from* Authors' abstract

Ahmed, S. M. *See* Walsh, J. H. 04561

Al Shaieb, Zuhair. *See* Mantel, Erwin. 04666

04774 **Alba, Roy S.; Pierce, Charles.** Phoenix Lake Field, Calcasieu Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 23-23c, illus., 1970.

04660 **Allan, R. J.; Hornbrook, E. H. W.** Development of geochemical techniques in permafrost, Coppermine River region: Canadian Mining Jour., v. 91, no. 4, p. 45-48, illus., 1970.

Almost 50 percent of Canada's land surface is underlain by permafrost. Previous geochemical exploration in permafrost areas of North America, and effects of a continuous permafrost zone on geochemistry are discussed, especially formation of haloes. Studies in the Coppermine River region, Northwest Territories, are cited as an example. The orebody is in Precambrian Coppermine Basalts in a feather fault off the Teshierpi fault; main ore minerals are chalcocite and bornite. Permafrost is found in the coarse till at depths of three to four feet. Water in two lakes downslope from the orebody contained anomalous amounts of Cu as did two in the fault valley. Anomalous Cu concentrations were determined in sediments of two streams crossing the mineralized zone. A geochemical anomaly map constructed from results of B horizon soils showed that the orebody could have been located by these. — ESL

Allen, Stephen H. *See* Moore, Clyde H., Jr. 04831

Allison, Richard C. *See* Blake, D. Bryan. 04715

04974 **Alverson, Roy M.** Deep well disposal study for Baldwin, Escambia and Mobile Counties, Alabama: Alabama Geol. Survey Circ. 58, 49 p., illus., table, 1970.

Baldwin, Escambia, and Mobile Counties have a combined area of 3,817 sq mi and a population of 396,900 (1960 census). The area encompasses the highly industrialized Mobile metropolitan area and the port of Mobile. The area of study is underlain by sedimentary rocks of the type used as reservoirs for waste disposal in other parts of the United States. Under certain geologic, hydrologic, and geochemical conditions it is believed that deep-well injection of liquid industrial waste can be carried out effectively in southwest Alabama. Each proposal, however, must be carefully evaluated, using the criteria outlined in this report to insure against pollution of freshwater supplies, surface and ground, and protect against damage to the environment in the subsurface or at the surface. — Author's abstract

Am. Geological Institute. *See* Geological Society of America. 04791

05070 **Am. Geophysical Union.** The geodynamics project: EOS, v. 51, no. 11, p. 712-713, 1970.

On the basis of recommendations made by an ad hoc committee, ICSU established the Inter-Union Commission on Geodynamics to plan and coordinate the Geodynamics Project. The statement of objectives prepared by the commission, approved by the ICSU General Assembly in September 1970, is presented here. The Project is focussed on movements at the surface and in the upper portions of the Earth's interior, and can logically be divided into four major parts dealing respectively with relative block movements, movements beneath blocks which affect them, primarily vertical movements within blocks, and past movements of blocks as reflected in the geologic record. Some working groups might be geographically oriented toward processes in the major mobile belts, others toward laboratory determinations and geophysical studies bearing on the physical properties and sources of energy at depth. — DBV

04816 **Amoruso, John J.** Possible future petroleum provinces of Gulf Coast Jurassic [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1781-1782, 1970.

05085 **Anders, Edward.** Water on the Moon?: Science, v. 169, no. 3952, p. 1309-1310, 1970.

If the planets formed at falling temperatures with volatile substances accreting last, the low abundance of lead, bismuth, indium, and thallium in lunar rocks implies an initial water content of no more than 370 grams per square centimeter, and probably much less. The depletion of volatile substances might be expected *a priori* if the Moon accreted as an original satellite of the Earth. — Author's abstract

Anderson, Don L. *See* Whitcomb, James H. 04661

04629 **Anderson, G. M.** Some thermodynamics of dehydration equilibria: Am. Jour. Sci., v. 269, no. 4, p. 392-401, illus., table, 1970.

Equilibrium between a hydrous mineral and its dehydration products is considered from the point of view of the equilibrium constant for the reaction and its variation with temperature and pressure. Emphasis is placed upon the explicit definition of all standard states involved. Using this approach and standard thermodynamical arguments, several of the many heats of reaction are calculated for the brucite dehydration reaction at 2000 bars. A method is given for the calculation of thermodynamically self consistent dehydration curves, given two points on the curve. This is illustrated with the brucite and muscovite dehydration reactions. — Author's abstract

04516 **Anderson, Michael M.** South Jennings Field, Jefferson Davis Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 26-26d, illus., 1970.

05063 **Angino, Ernest E.** Selective element recovery from oil field brines, *in* Saline water symposium: Water Resources Research, v. 6, no. 5, p. 1501-1504, illus., table, 1970.

Recovery of compounds dissolved in subsurface brines takes on greater importance with each passing year. More than 325 billion gallons of oil field brines are brought to the surface yearly in the United States, most of which are wasted and/or returned to the subsurface without any attempt to strip the contained salts. This volume of brine warrants greater consideration of the feasibility of extracting the dissolved components. In many instances salts dissolved in oil field brines could be extracted profitably, if modern techniques were used. For example, sulfur can be recovered by using a barium resin to precipitate $BaSO_4$, which can be made to yield sulfur by a short four-step conversion process. Magnesium can be precipitated in the hydroxide form, and selected trace elements can be scavenged and concentrated by ferric iron precipitation. — *from* Author's abstract

04817 **Anisgard, Harry W.** Causes of dominantly arenaceous foraminiferal assemblages in downdip Wilcox of Louisiana [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1782, 1970.

05057 **Appleby, F. Victor.** Recession and the baseflow problem: Water Resources Research, v. 6, no. 5, p. 1398-1403, illus., 1970.

Baseflow as a hydrograph component is discussed with special reference to Hall's [1968] paper 'Base-Flow Recession — A Review.' Additional references with particular emphasis on the baseflow problem are given. A three parameter baseflow partition functional is shown to give substance to the concept of 'group persistence' and to suggest an underlying mechanism to the Hurst statistical phenomenon. — Author's abstract

Applin, Esther R. *See* Cole, W. Storrs. 04658

04922 **Armstrong, Augustus K.** Mississippian rugose corals, Peratrovich Formation, west coast, Prince of Wales Island, southeastern Alaska: U.S. Geol. Survey Prof. Paper 534, 44 p., illus., table, 1970.

The three members of the Peratrovich Formation represent continuous marine sedimentation from Osage to late Chester time; the chert (200 feet), limestone and chert (400 feet), and limestone (400 feet) members were deposited successively in euxenic, normal marine, and clear-water shoaling environments. Fourteen species of rugose corals are described, including seven new. The abundant coral fauna of the limestone and chert member is of Meramec age, suggestive of correlation with the Mount Head Formation, Alberta, and includes the new species *Faberophyllum williamsi*, *F. girtyi*, *Diphyphyllum venosum*, *D. klawockensis*, *Lithiostrotionella birdi*, *Sciophyllum alaskensis*. The much less abundant fauna of the limestone member, late Meramec-late Chester, includes the new species *Lithostrotionella peratrovichensis*, *Lithostrotion* (*Siphonodendron*) *succinctus*. — VMJ

Armstrong, Frank C. *See* Society of Economic Geologists. 04909

04717 **Ash, Sidney R.** *Pagiophyllum simpsonii*, a new conifer from the Chinle Formation (Upper Triassic) of Arizona: Jour. Paleontology, v. 44, no. 5, p. 945-952, illus., 1970.

The new coniferous species *Pagiophyllum simpsonii* is described from fragments of leafy shoots collected from beds above the Sonsela Sandstone in the upper part of the Petrified Forest Member of the Upper Triassic Chinle Formation in Petrified Forest National Park, Arizona. Particular attention is given to details of the cuticle, which is well preserved in this material. — SHM

Avignone, Nicholas F. *See* Swift, Donald J. P. 04724

05035 **Baar, C. A.** Correct interpretation of data for better understanding of salt pillar behaviour in mines, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 280-289, illus., tables, 1970.

Laboratory tests differ from in situ tests largely because laboratory samples are usually being loaded whereas the rock salt surrounding a newly created mine opening is unloaded at least in one direction of stress. A number of erroneous conclusions based on laboratory tests and inapplicable theoretical assumptions have been published. Large numbers of in situ measurements are needed for the better understanding of rock salt behavior under mining conditions. — *from* Author's abstract

04751 **Babcock, Clarence.** Oil and gas activities in Florida, 1967: Florida Bur. Geology Inf. Circ. 63, 32 p., illus., tables, 1970.

This report includes information on the Sunoco-Felda and Sunniland oil fields, exploration activity, a bibliography, and well data sheets for 1967. — MCM

04992 **Bada, Jeffrey L.; Luyendyk, Bruce P.; Maynard, J. Barry.** Marine sediments — Dating by the racemization of amino acids: Science, v. 170, no. 3959, p. 730-732, illus., table, 1970.

Isoleucine has been found to undergo a slow racemization reaction in a 5-meter sediment core taken from the Atlantis fracture zone (water depth, 4,014 meters; actual location, 30°15.7′ N., 43°18.9′ W.). The amount of racemization increases with increasing depth below the sediment-seawater interface. This isoleucine racemization reaction was used to calculate an age of 1.23 million years for the bottom of the core. — Authors' abstract

Baker, Arthur A. *See* Bromfield, Calvin S. 04511

04769 **Bales, J. R.** Lewisburg Field, Acadia Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 17-17c, illus., 1970.

Ball, Mahlon M. *See* Neumann, A. Conrad. 04943

04490 **Ballard, Robert D.; Uchupi, Elazar.** Morphology and Quaternary history of the continental shelf of the gulf coast of the United States: Bull. Marine Sci., v. 20, no. 3, p. 547-559, illus., 1970.

Sea-level fluctuations of the Quaternary have greatly influenced the surface morphology of the continental shelf off the gulf coast of the United States. Two prominent shorelines, at 60- and 160-m depths, and other features found on the gulf shelf can be related to the relatively recent events of the Quaternary, particularly those of the Holocene transgression. Landward of the 40-m contour, the slow rise of the sea surface and modern sedimentation have produced a complex mixture of topographic expressions. Diapiric structures, which are abundant from De Soto Canyon westward, appear to be of secondary importance in contribution to the shelf's surface relief. — Authors' abstract

Balsiger, H. *See* Pelly, I. Z. 04524

04874 **Bandy, Orville L.; Wilcoxon, James A.** The Pliocene-Pleistocene boundary, Italy and California: Geol. Soc. America Bull., v. 81, no. 10, p. 2939-2947, illus., 1970.

The Pliocene-Pleistocene boundary is at or near the base of the Calabrian in Italy and within the Wheelerian Stage of Balcom Canyon, California, and thought to be correlative with the base of the Gilsa magnetic event, about 1.79 m.y. ago. A cooler climatic interval is recorded in the late Pliocene of Italy and of California, and the Pliocene-Pleistocene boundary is assigned near the base of a slightly warmer cycle. A long preglacial Pleistocene (Calabrian) is followed by the major glacial Pleistocene which is thought to coincide mostly with the Brunhes normal magnetic epoch. A major cooling in Italy is recognized near the base of the Lomita Marl in southern California, a formation dated as about 3 m.y. old. This age may be slightly more than three times too great. — EHP

04959 **Bandy, Orville L.** Upper Cretaceous-Cenozoic paleobathymetric cycles, eastern Panamá and northern Colombia [abs.]: Am. Assoc. Petroleum geologists, v. 54, no. 9, p. 1782, 1970.

04934 **Banister, D'Arcy P.** Geochemical investigations for gold, antimony, and silver at Stibnite, Idaho: U.S. Bur. Mines Rept. Inv. 7417, 7 p., illus., 1970.

The humus geochemical technique has promise as an exploration tool at Stibnite and in much of central Idaho because it overcomes some of the problems associated with surface leaching and gold too fine to pan. Initial geochemical reconnaissance efforts were limited to areas near flat-dipping northeast-trending faults. The sampling program failed to provide conclusive evidence that the faults are the loci of large low-grade ore bodies. Anomalies north and south of Garnet Creek indicate that the "Scout Ridge" deposit will extend almost to the surface, and that it is longer than originally thought. Diamond drill holes from the valley flat many years ago had indicated a small, deeply buried deposit. The humus sampling results also indicate the West End Creek deposits to be more extensive. Whether the anomalies near Fiddle Creek and west of Garnet Creek are related to mineralized northeast-trending structures or to weathered material migrating from Meadow Creek fault remains uncertain. — *from* Author's abstract

04878 **Banks, Norman G.** Nature and origin of early and late cherts in the Leadville Limestone, Colorado: Geol. Soc. America Bull., v. 81, no. 10, p. 3033-3048, illus., 1970.

Two generations of diagenetic chert observed in the Leadville Limestone are: (1) an early chert inferred to have precipitated from hypersaline marine waters of high pH after those waters seeped into carbonate muds prior to final burial and lithification of the carbonate; and (2) a late chert that appears to have precipitated from ground waters as amorphous silica after internal lithification but before or during karst erosion of the formation. The early chert in the Leadville probably formed under conditions similar to those producing modern early diagenetic chert. Silica of the late chert probably came from Paleozoic sandstones below the Leadville, and was carried into the formation by slightly acid waters that may simultaneously have removed the calcite that was replaced by chert. Supersaturation of amorphous silica probably occurred by evaporative concentration at the water-air interface during dry seasons. — *from* Author's abstract

04624 **Barazangi, Muawia; Dorman, James.** Seismicity map of the Arctic compiled from ESSA, Coast and Geodetic Survey, epicenter data January 1961 through September 1969: Seismol. Soc. America Bull., v. 60, no. 5, p. 1741-1743, illus., 1970.

A seismicity map is presented of the Arctic region north of lat 70° N., containing 310 epicenters for the period January 1, 1961, through September 30, 1969. All focuses are less than 100 m deep. — DBV

Barazangi, Muawia. *See* Seeber, Leonard. 04687

Barlow, James A., Jr. *See* Haun, John D. 04649

04646 **Barringer, A. R.** Remote-sensing techniques for mineral discovery, *in* Mining and petroleum geology — Commonwealth Mining and Metall. Cong., 9th, United King-

dom, 1969, Proc., V. 2: London, Inst. Mining and Metallurgy, p. 649-690, illus., tables, 1970.

Remote sensing as applied to mineral exploration covers all detection and mapping methods which can be used from an aircraft or spacecraft. Recent developments such as applications of color infrared photography, very low frequency radio transmissions, optical-mechanical line-scanning infrared systems, and side-looking radar are reviewed. Optical correlation methods of remote detection of trace gases over natural resource features are described, together with spectral scanning methods in the thermal infrared region for remote identification of rock types. Brief reference is made to developments in gamma-ray spectroscopy and to air sampling methods for airborne geochemical surveys. Use of aircraft and satellite imaging systems for large-scale regional geologic interpretation, followed by airborne geophysical, geochemical, and geologic reconnaissance surveys for localizing targets for follow-up ground methods is discussed in detail. — *from* Author's abstract

04956 **Bartholomew, M. J.** San Jacinto fault zone in the northern Imperial Valley, California: Geol. Soc. America Bull., v. 81, no. 10, p. 3161-3166, illus., table, 1970.

The San Jacinto fault zone consists of three principal faults: the San Jacinto, Coyote Creek, and Clark faults. Right-lateral horizontal displacement along these faults is 14 mi, 3 mi, and 1 mi, respectively. Vertical displacement is relatively minor. The faulting appears to have occurred since the middle Pleistocene. Clark Valley, which is similar to Death Valley, is interpreted as a pull-apart graben along the curvilinear San Jacinto fault. — Author's abstract

04609 **Bartholomew, R. L.; Matten, L. C.; Wheeler, E. F.** Staining silicified woods: Jour. Paleontology, v. 44, no. 5, p. 905-907, illus., 1970.

Colorless silicified woods can be stained by the use of Bismarck brown Y and Malachite green; the latter stain is especially effective for differentiation of silicified tissues. — SHM

04757 **Bates, Fred W.; Copeland, Robert R.; Bates, Marc W.** Belle Isle Field, St. Mary Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 5-5c, illus., 1970.

Bates, Marc W. *See* Bates, Fred W. 04757

Bates, R. G. *See* Cohee, G. V. 04694

05105 **Bean, Alan L.; Conrad, Charles, Jr.; Gordon, Richard F.** Crew observations, *in* Apollo 12 preliminary science report: U.S. Natl. Aeronautics and Space Adm. Spec. Pub. SP-235, p. 29-38, 1970.

First-hand observations include comments on Earth and Moon from orbit, adaptability of the crew to the lunar environment, geology and soil mechanics of the surface and Surveyor site, and discussion of the solar eclipse witnessed enroute back to Earth. — JHF

04675 **Beeson, Marvin H.** Age dating and radioactive isotopes [summ.]: Geol. Soc. Oregon Country News Letter, v. 36, no. 2, p. 8-9, table, 1970.

Early methods of age determination before Roentgen discovered radioactivity in 1895 are reviewed. These were based on the principle of stratigraphic superposition and the law of faunal succession. In the last 50 years, calibration of the geologic column has been based on absolute ages determined by radioactive isotopes. A radioactive decay chart is given for isotopes used in dating. Two new methods of correlation have become important recently; a column based on polarity changes is being constructed, and trace-element abundances in volcanic ash are proving useful in correlating isolated ash layers. — ESL

04758 **Bell, John; Holmes, John; Schoelen, John.** West Cameron Block 180 Field, West Cameron area, offshore Cameron Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 6-6d, illus., 1970.

Bell, Kenneth G. *See* Harshman, E. N. 04483

04517 **Bellamy, James J.** Topsy-Thompson Bluff-Indian Village Fields, Jefferson Davis Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 28-28d, illus., 1970.

04486 **Bentzen, Edwin H., 3d.** Chemical composition of some North Carolina chromite: Econ. Geology, v. 65, no. 7, p. 883-885, table, 1970.

New data are presented on 12 known chromite occurrences in North Carolina which document the high Cr_2O_3 content of these chromites. The beneficiation procedure is described; the chemical analysis procedure used is that described by Dinnin (1959). Results of tests on 10 of the 12 samples treated indicate a Cr_2O_3 content of 50 percent or better; no deposit indicated a sufficient quantity or quality of chromite to warrant processing exclusively for that mineral. However, processing as a by-product of olivine production is a possibility. — VSN

04607 **Berg, H. C.** Alaska's mineral resources — Past, present, and future: Canadian Mining Jour., v. 91, no. 4, p. 53-56, 1970.

The role of the U.S. Geological Survey in the search for Alaska's mineral resources is discussed. Since 1960, more than 19,000 new claims have been staked for metallic minerals, but as of 1969, there are only two or three small producing hardrock mines. Alaska is an extension of three of the greatest metal-producing domains in the western hemisphere. The Survey acquires and disseminates new geologic information by four main programs: geologic mapping, making an inventory of resources, geophysical investigations, and developing and applying new exploratory techniques. Each program is discussed at some length, including use of the computer. The future possibilities are divided into four major categories: spinoff (the beneficial effect on mining from growth of other industries), legislative actions, technology, and environmentalism. — ESL

04699 **Berg, R. B.; Lawson, D. C.; Jones, F. P.; Smith, R. I.** Progress report on clays and shales of Montana, 1968-1969 (samples 636-727): Montana Bur. Mines and Geology Bull. 80, 27 p., illus., tables, 1970.

This report, seventh in the series, presents results of ceramic tests, bloating tests, X-ray diffraction analyses, and chemical analyses (including available alumina for selected samples). Of 34 samples from sedimentary rocks surrounding the Pryor Mountains, one was judged suitable for good quality common brick, and six others would be capable of producing fair quality brick. Generally the better clays for ceramic use were those collected from the Cloverly Formation (Cretaceous). Of 45 samples from the Tongue River Member of the Fort Union Formation (Paleocene) obtained from holes drilled for the evaluation of the coal resources of eastern Montana, one was judged suitable for a fair grade of common brick, and 22 others might find some ceramic use. Four samples produced bloated material suitable for use as lightweight aggregate. — Authors' abstract

04620 **Berg, Richard B.** Bentonite deposits in the Ingomar-Vananda area, Treasure and Rosebud Counties, Montana: Montana Bur. Mines and Geology Spec. Pub. 51, 5 p., illus., tables, 1970.

Numerous beds of bentonite within the Bearpaw Shale (Cretaceous) are extensively exposed in the Ingomar-Vananda area in Treasure and Rosebud Counties, Montana. Reconnaissance mapping shows the distribution of two bentonite beds 3 to 4 feet thick separated by approximately 10 feet of montmorillonitic shale. Although the regional structure of this area is relatively simple, steeply dipping faults are abundant, especially in the vicinity of Cedar Ridge. Viscosity and gel strength determinations

on both untreated bentonite samples and those to which Na_2CO_3 has been added show a wide variation. — Author's abstract

04818 **Berg, Robert R.** Criteria for identification of sedimentary environments in reservoir sandstones [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1782-1783, 1970.

04548 **Berger, Jon; Lovberg, R. H.** Earth strain measurements with a laser interferometer: Science, v. 170, no. 3955, p. 296-303, illus., 1970.

This paper describes the 800-m Michelson interferometer used to monitor the Earth's strain field, which operates above the surface of the ground. The instrument has a strain least count of 10^{-10}, requires no calibration, and has a flat and linear response from zero frequency to 1 megahertz. It offers unprecedented versatility in the recording of seismic strains associated with earthquakes and nuclear blasts. The extremely wide bandwidth opens new areas of the strain spectrum to investigation. Measurements of secular strain and earth tides indicate that even at these long periods, surface strain measurements are valid representations of earth strain at depth; the laser strain meter thus provides means of making crustal strain measurements at points selected for maximum geophysical interest and ultimately allows the mapping of strain field distributions. — DBV

Bermingham, John J. *See* Bretsky, Peter W. 04714

04679 **Berner, Robert A.; Scott, Martha R.; Thomlinson, Catherine.** Carbonate alkalinity in the pore waters of anoxic marine sediments: Limnology and Oceanography, v. 15, no. 4, p. 544-549, illus., tables, 1970.

The principal factor affecting carbonate alkalinity in pore waters of organic-rich aluminosilicate muds from the central Connecticut coast and a Maine fjord is bacterial sulfate reduction. Measured (titration) alkalinity is equal to that calculated from measured changes in SO_4^{2-}, Mg^{2+}, Ca^{2+}, and NH_4^+. As a result of alkalinity increase, pore waters of anoxic sediments can become highly supersaturated with $CaCO_3$. Precipitation of $CaCO_3$ may not occur, however, possibly because of the inhibiting effect of dissolved organic matter. No evidence is provided by these sediments for authigenic aluminosilicate formation. — Authors' abstract

04521 **Berry, William B. N.** Review of late Middle Ordovician graptolites in eastern New York and Pennsylvania: Am. Jour. Sci., v. 269, no. 3, p. 304-313, table, 1970.

The latest Middle Ordovician graptolite zone, zone 13 as it has been recognized, may be divided into a lower and an upper subzone. The youngest Middle Ordovician shale sequence rocks in eastern New York and eastern Pennsylvania, those directly beneath the unconformity between them and the overlying Silurian or Devonian rocks, bear graptolites of the upper subzone of zone 13; the youngest rocks in the "wildflysch-type conglomerate" of Zen and the shale matrix of that unit bear graptolites of the lower subzone. The youngest Taconic allochthonous or epikinallochthonous rocks contain those of zone 12. Faunal provinciality between eastern and western North American Late Ordovician graptolite faunas began during zone 13 time, approximately contemporaneous with the commencement of Taconic movements. — *from* Author's abstract

04767 **Bethke, W. M.** Kings Bayou Field, Cameron Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 15-15d, illus., 1970.

04743 **Betzer, Peter R.; Pilson, M. E. Q.** The Nansen bottle, a major contributor to reported concentrations of particulate iron in sea water: Deep-Sea Research, v. 17, no. 3, p. 671-674, illus., table, 1970.

Concentrations of particulate iron in sea water samples collected in Teflon coated Nansen bottles were 15-86 times as high as those collected in 30-l Niskin bottles at the same time, depth, and station. It is concluded that the results of any studies of

particulate iron in sea water which made use of the Nansen bottle may have been affected by contamination. — Authors' abstract

04662 **Bhasin, Rakhishwar N.** Erodibility of channels with cohesive boundary — Discussion [of paper 7156 by E. Partheniades and R. E. Paaswell, 1970]: Am. Soc. Civil Engineers Proc., v. 96, Jour Hydraulics Div., no. HY 9, p. 1918-1919, 1970.

Paper 7156 (ibid., no. HY3, p. 755-771, 1970) was cited in Abs. North American Geology, November 1970.

04819 **Biel, Ralph.** Composition of some Miocene and Holocene planktonic foraminiferal assemblages [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1783, 1970.

Bingham, Elizabeth. *See* Nichiporuk, Walter. 04990

04541 **Bird, Samuel C.** Shallow-marine and estuarine benthic molluscan communities from area of Beaufort, North Carolina: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 9, p. 1651-1676, illus., tables, 1970.

Mollusk abundance data from 65 stations show evidence of level-bottom communities in transition. Three communities or associations occur within the Newport River estuary. From estuary mouth to head they are *Tellina, Mulinia-Syndosmya, Retusa; Syndosmya-Aligena*; and *Macoma balthica*; only the last named is sharply delineated. The estuary mouth association grades into the shallow open-ocean *Tellina-Spisula* community. Analysis results of several physical parameters relating to distribution are inconclusive. Salinity (and its correlative here, water depth) is more important than other factors studied. Important species are illustrated, and their probable optimum conditions and trophic level are given. — *from* Author's abstract

04851 **Bissell, H. J.** General geology of the High Plateaus and eastern Basin Ranges, Utah, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 42-52, illus., table, 1970.

Generally Paleozoic and Mesozoic strata are marine while those of the Cenozoic are lacustrine and fluvial. The best record of Paleozoic miogeosynclinal sedimentation is found in ranges of the eastern Great Basin, whereas cratonic rocks formed to the east; the Wabash line is the tectonic hinge separating them. A correlation chart and stratigraphic columns are included. In the Mesozoic a transition was made from Cordilleran to Rocky Mtn. geosyncline, which reached its maximum during the Cretaceous. The Laramide orogeny began in about mid-Cretaceous. Cenozoic time was typified by intermontane basins containing lakes, including Lake Green River, and by block faulting. Glaciation was limited to parts of the Uinta and Wasatch Mts. and high areas of the High Plateaus. History of the Lake Bonneville substages is reviewed. Besides this sedimentary record, there were numerous intrusions and flows. — ESL

Black, B. Allen. *See* Rigby, J. Keith. 04706

04784 **Blackmore, A. V.** The Poiseuille analogue for flow of water in Wyoming bentonite: Jour. Hydrology, v. 11, no. 1, p. 59-68, illus., 1970.

Water movement, parallel to the plane of orientation, is measured in a Wyoming bentonite as a function of hydrostatic pressure gradient and interparticle spacing. Data are interpreted with the object of establishing a mathematical model based on the slit analog of the Poiseuille equation, modified for electro-osmosis and anomalous viscosity, as suggested by Kemper. Pore velocity, at constant spacing, is very nearly proportional to pressure gradient (Darcy's Law); at constant pressure gradient it is linearly related to the square of the spacing. When implications of these results are applied to the analog an expression is obtained that describes the flow in a satisfactory manner, and may be compared with one developed for flow in inert materials both within and beyond limits of the present experiment. — *from* Author's abstract

04632 **Blair, W. Frank.** Genetically fixed characters and evolutionary divergence, *in* Ecology and the origin of species — Am. Soc. Zoologists and Ecol. Soc. America, Symposium, Dallas, Tex., 1968: Am. Zoologist, v. 10, no. 1, p. 41-46, illus., 1970.

The nearly cosmopolitan genus of toads, *Bufo*, is a rare example of an ancient conservative evolutionary line of which enough species survive to permit testing the degree of genetic change by interspecific hybridization. The fossil record indicates a major dichotomy into broad-skulled warmth-adapted and narrow-skulled cold-adapted lines in the New World more than 15 m.y. ago (Oligocene-Miocene). The narrow-skulled toads reached Africa at least twice; after separation for an estimated 10 m.y., some Eurasian-North African and New World species remain genetically similar enough to produce viable hybrids in both reciprocals. Broad-skulled toads have been in Africa for at least 15 m.y., but the females of at least one species produce viable hybrids with New World broad-skulled males. Evolutionary conservatism of *Bufo* contrasts with the rapid change in *Rana*. — VMJ

04715 **Blake, D. Bryan; Allison, Richard C.** A new west American Eocene species of the Recent Australian ophiuroid *Ophiocrossota*: Jour. Paleontology, v. 44, no. 5, p. 925-927, illus., 1970.

Ophiocrossota baconi, a new species of ophiuroid, is described from the upper Eocene lower Coaledo Formation [near Cape Arago], Oregon. Specimens questionably assigned to the species are also reported from the middle Miocene Branch Canyon Formation of California. The only known Recent species of *Ophiocrossota* occurs in South Australia. — Authors' abstract

04948 **Blank, Horace R.** Incised meanders in Mason County, Texas: Geol. Soc. America Bull., v. 81, no. 10, p. 3135-3140, illus., 1970.

Meanders moderately incised in a limestone plateau are interpreted to have developed from round meanders under the influence of two sets of vertical joints.

04696 **Blondel, Fernand; Lasky, Samuel G.** Concepts of mineral reserves and resources, *in* Survey of world iron ore resources, occurrence and appraisal: New York, United Nations Dept. Econ. and Social Affairs, p. 53-58, table, 1970.

Basic concepts, and terms used, do not have the same meaning for everyone. Geologic and economic indeterminates are defined and their role in estimating reserves is discussed. The geologic indeterminate is stressed, introducing the terms, possible reserves, a geologic estimate, becoming probable if tests justify it. More important tests may transform this to proved reserves. Terms for mineral reserves of a deposit have been transferred to mineral resources of an entire region without realizing that two different concepts were involved. Estimates for regions are more properly expressed as inferred, indicated, and measured. It is suggested that reserves be used for mineral masses considered exploitable under existing economic and local conditions; demonstrated for combined measured plus indicated reserves; and potential for those which, to be exploited, demand more favorable conditions. — ESL

04704 **Blow, W. H.** Validity of biostratigraphic correlations based on the Globigerinacea: Micropaleontology, v. 16, no. 3, p. 257-268, 1970.

The influence of dynamic environment is considered in relationship to the probable degree of isochroneity which might be reasonably expected for the various types of planktonic foraminiferal zones. Zones based on "local extinctions" are considered to have a considerable degree of "in-built" diachroneity, and recommendations are made for the replacement of this type of zone by zones derived from evolutionary considerations. Some heterochronous repetitive evolutionary sequences are also considered as not suitable for biostratigraphic correlations. The concept of "datum-planes" is examined; these are considered as largely misleading and should not replace the concept of formally defined zones. Examples of variation of end-ranges of taxa are considered for the late Pliocene/Pleistocene and for the Oligocene. A proposal to combine Zone P.19 and Zone P.20 (=N.1) (Blow, 1969) into a new single "Zone P.19/20" is also made. — *from* Author's abstract

04994 **Bock, Wayne D.** *Hyalinea baltica* and the Plio-Pleistocene boundary in the Caribbean Sea: Science, v. 170, no. 3960, p. 847-848, illus., 1970.

The foraminifer *Hyalinea baltica* is found for the first time in sediments from the western Caribbean Sea. Its relationship to the Plio-Pleistocene boundary and to other criteria used to define this boundary is examined, with the result that a strict adherence to the classical definition is urged. — Author's abstract

Bogyo, Thomas P. *See* Mastrogiuseppe, Joy D. 04926

04539 **Bolt, Bruce A.** PdP and PKiKP waves and diffracted PcP waves: Royal Astron. Soc. Geophys. Jour., v. 20, no. 4, p. 367-382, illus., tables, 1970.

Traveltimes of longitudinal waves at epicentral distances of 100°-115° from 16 earthquakes with depths near 100 km give rather precise information on properties of the Earth in the upper third of the mantle, at the inner core boundary, and at the bottom of the mantle. PdP precursors to PP provide further evidence that, above at least 400 km depth, the upper mantle contains global scale discontinuities possibly due to phase changes. PKiKP waves, reflected from the inner core, are traceable back to 106°, which is consistent with a sharp inner core boundary at 1,220 km radius. Observed PkP times near 113° are closely consistent with PKiKP times. Traveltimes of PcP, diffracted into the shadow zone, lead to a core radius of 3,479 ± 2 km. There is an indication that P velocity may decrease by a few percent at the base of the mantle. — DBV

Bolter, Ernst. *See* Mantel, Erwin. 04666

Bondar', L. N. *See* Troitskiy, V. S. 05096

05080 **Boneham, Roger F.** Devonian plant remains in a Pleistocene glacial deposit: Am. Midland Naturalist, v. 84, no. 1, p. 252-253, illus., 1970.

Tasmanites and acritarchs are present in a Wisconsin age till at Marion County, Indiana. These fossils are most likely redeposited by glacial action from the New Albany Shale. — Author's abstract

Bonham-Carter, Graeme. *See* Harbaugh, John W. 04790

05053 **Borgeson, O. W.** Wabush story — Pt. 2, Mining and geology, Scully mine, *in* Mining Symposium, 31st Ann., and AIME, Minnesota Sec., 43d Ann. Mtg., Duluth, 1970: Minneapolis, Minn., Univ. Minnesota, p. 13-16, illus., 1970.

The Scully mine is in the southwest corner of Labrador where the ore deposit covers five and one-half square miles. The iron-formation consists of lower, middle, and upper members with basal silicates and a ferruginous quartzite in the middle. Twenty percent of the formation must be discarded because it is too low grade or contains too many impurities. Mining operations are carried on by conventional open-pit methods and equipment, which are described. The usual problems are compounded by the geographic location and the severe climate. The application of computers to mine grading and estimating is a feature not usually found in other operations. — ESL

Boswell, E. H. *See* Cushing, E. M. 04550

04659 **Bottinga, Y.; Weill, Daniel F.** Densities of liquid silicate systems calculated from partial molar volumes of oxide components: Am. Jour. Sci., v. 269, no. 2, p. 169-182, illus., tables, 1970.

The partial molar volumes of SiO_2, Al_2O_3, MgO, SrO, CaO, FeO, Li_2O, Na_2O, and K_2O have been calculated from published density measurements in binary and ternary silicate melts. These partial molar volumes (with the possible exception of Li_2O) show little composition dependence in liquids ranging from 40 to 80 mole percent SiO_2. Partial molar volumes at 1400°C are: SiO_2 = 26.80, Al_2O_3 = 37.96, MgO =

11.60, CaO = 16.50, SrO = 21.75, FeO = 12.8, Li_2O = 17.14, Na_2O = 28.90, K_2O = 46.00 (cm^3/mole). The respective coefficients of thermal expansion (1200-1700°C) are: 0.9, 2.6, 24, 18, 13, 16, 24, 24, and 30 ($°C^{-1} \times 10^{-5}$). The above data and estimates for the partial molar volumes of Fe_2O_3, MnO, and TiO_2 allow calculation of the density of most magmatic liquids. — Authors' abstract

Bottino, Michael L. *See* Fullagar, Paul D. 04866

04713 **Boucot, A. J.; Johnson, J. G.** Redescription of *Clintonella* Hall (Silurian, Brachiopoda): Jour. Paleontology, v. 44, no. 5, p. 893-897, illus., 1970.

Clintonella Hall is a rhynchonelliform Silurian brachiopod genus that has never been well known morphologically, nor has it been widely reported beyond the known occurrences in New York. New collections from the Wallington Limestone, Clinton Group, in Wayne County, N.Y., demonstrate a late Llandovery (C_3-C_4) age for specimens of *Clintonella* cf. *C. vagabunda*. The genus has been compared to genera assigned variably to the Athyridacea, Atrypacea, and Rhynchonellacea, but the genera in question, *Plectothyrella* and *Aratanea*, are best regarded as rhynchonellids. *Clintonella* is concluded to be an atrypid that owes its rhynchonellid appearance to convergence. — *from* Authors' abstract

04721 **Boucot, A. J.** *Glypterina*, new genus, the Ordovician ptychopleurellid: Jour. Paleontology, v. 44, no. 5, p. 984-985, 1970.

The ptychopleurellids [orthacean brachiopods] of the Ordovician, which almost entirely possess unbranched or weak secondary costae lateral to the median costa, are assigned to the new genus *Glypterina*, as distinct from the Siluro-Devonian ptychopleurellids which pertain to *Ptychopleurella*. Early growth stages of the Siluro-Devonian ptychopleurellids have unbranched lateral costae, but the shells reach a greater size than do Ordovician ptychopleurellids, the larger specimens invariably having branched lateral costae. [Species assigned herein to *Glypterina* and to *Ptychopleurella* are listed for North America, Europe, and Asia.] — Author's abstract

04820 **Bowen, Richard L.** Epi-Paleozoic hypersalinity and marine biotic extinctions [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1783, 1970.

Bowen, Zeddie P. *See* Sutton, Robert G. 04950

04854 **Bowman, Frank O., Jr.** (compiler). First day road log from Denver to Grand Junction, via U.S. Highway 6, Idaho Springs and Glenwood Springs, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 79-88, 1970.

04855 **Bowman, Frank O., Jr.; Smith, Clay T.** Second day road log from Grand Junction, Colorado to Cedar City, Utah, via Cisco, Utah 128, Moab, Green River, Hanksville, Capital Reef National Monument, Kingston and Long Valley Junction, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 89-93, 1970.

04859 **Bowman, Frank O., Jr.; Smith, Clay T.** (compilers). Sixth day road log from Cedar City, Utah to Durango, Colorado via Long Valley Junction, Kanab, Jacob Lake, Marble Canyon, Tuba City, Mexican Hat, Aneth, and Cortez, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 132-135, 1970.

04864 **Bowman, Frank O., Jr.** (compiler). Seventh day road log from Durango to Denver, Colorado via Ouray, Montrose, Gunnison, Nathrop, Fairplay, and Morrison, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region —

Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 168-181, 1970.

05076 **Boyle, R. W.; Wanless, R. K.; Stevens, R. D.** Sulfur isotope investigations of the lead-zinc-silver-cadmium deposits of the Keno Hill-Galena Hill area, Yukon, Canada — A reply [to discussion by D. J. Templeman-Kluit, 1970]: Econ. Geology, v. 65, no. 6, p. 731-732, 1970.

For original paper, *see* ibid., no. 1, p. 1-10, 1970; Abs. North American Geology, February 1971.

04966 **Boyum, Burton H.** The Marquette mineral district, Michigan, *in* Geol. Soc. America field trip to Marquette Iron Range, Michigan, Nov. 1970: [n.p.] 21 p., paged separately, illus., 1970.

Iron, discovered in the Lake Superior district in 1844, continues to hold major mining interest (378,949,000 long tons produced 1852-1969), with some gold. Principal rock units are Precambrian, structurally part of the Canadian Shield; the thick Animikie series in a long west-plunging synclinorium, older rocks are to the north, and all are intruded by rocks of Keweenawan age. Summarized are the Chocolay, Menominee, and Baraga Groups; beyond a faulted segment on the southeast, are Cambrian and Ordovician sandstones and limestones. Metamorphic intensity decreasing eastward, isograds cross geologic structures at high angles. Primary iron-formation was oxidized and enriched under varying conditions; its permeability was increased by folding and joints. Four types of ores are produced; their occurrence and theories of genesis are reviewed. — GDC

04507 **Braddock, William A.; Nutalaya, Prinya; Gawarecki, Stephen J.; Curtin, Gary C.** Geologic map of the Drake quadrangle, Larimer County, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-829, scale 1:24,000, 1970.

04916 **Bradley, O. E.** Geology of the Jersey lead-zinc mine, Salmo, British Columbia, [Chap.] 8 *in* Lead-zinc deposits in the Kootenay Arc, northeastern Washington and adjacent British Columbia — Soc. Econ. Geologists, 1970 Northwest Field Conf. Guidebook: Washington Div. Mines and Geology Bull. 61, p. 89-98, illus., 1970.

The Jersey mine lies eight miles south of Salmo in the Kootenay arc. Ore bodies are contained in dolomite in the Reeves Limestone; mineralization consists of fine-grained sphalerite and galena. Dominant structure is the Jersey anticline and ore bodies lie in secondary folds on the upper limb. A reverse fault bounds the mine area on the east, and normal faults cut the ore bodies. Five bands of ore are recognized, parallel to sedimentary banding. Lead-zinc ratios are about one to four. Cross-cutting dikes suggest ore emplacement before granitic intrusion. — *from* Author's abstract

04663 **Bradshaw, Peter M. D.; Clews, D. Richard; Walker, John L.** Exploration geochemistry — Pt. 5, Field and laboratory procedures: Mining in Canada, August 1970, p. 25-33, illus., tables, 1970.

In the four previous articles specific reference was made to the principles of geochemical exploration, and this involved a discussion of the mechanisms of geochemical migration. While a fundamental understanding of the underlying principles of exploration geochemistry is essential if the full scope of this technique is to be realized, the practical aspects of sample collection and analysis are equally important. This article is devoted to these aspects. — GV

04672 **Bradshaw, Peter M. D.; Clews, D. Richard; Walker, John L.** Exploration geochemistry — Pt. 4, Primary dispersion: Mining in Canada, June 1970, p. 24-31, illus., tables, 1970.

This fourth article in the series examines the different types of geochemical dispersion in unweathered bedrock and their uses in mineral exploration. Exploration using primary dispersion is a powerful tool, particularly during diamond drilling phases and

underground development, and deserves wider recognition and application in Canada where the presence of glacially transported overburden restricts the use of the more conventional geochemical methods. Succeeding articles will discuss laboratory methods of analyzing geochemical samples and the effect of different types of sample handling and interpretation. Also, field collection procedures, Canadian problems and the future of exploration geochemistry will be covered. — GV

Bradshaw, R. L. *See* Empson, F. M. 04639

04520 **Bray, J. R.** Temporal patterning of post-Pleistocene glaciation: Nature, v. 228, no. 5269, p. 353, 1970.

Most post-Pleistocene glaciation has been confined to four phases at intervals of about 2,600 years. The exact timing of these phases is examined in relation to recent radiocarbon ages and additional glacial chronologies. The apparent cyclic recurrence of the four phases and their synchronism suggest they have a similar cause; their occurrence near the thermal maximum suggests that the underlying mechanism is independent of that determining the predominant Holocene temperature trend. There are two major Holocene temperature patterns which are causally independent but additive in expression, one related to changes in the Earth's orbit relative to the Sun, and the other to cyclic intervals of decreased solar activity. If the patterns continue, a possible new glacial era may begin around AD 4300 (the next predicted 2,600-yr temperature decline) or sooner if the rapid cooling predicted (from the first pattern) to occur after AD 2450 is sufficient. — DBV

04849 **Breed, Carol S.** Two hypotheses of the origin and geologic history of the Colorado River, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 31-34, illus., table, 1970.

Any hypothesis must explain the following: the eastern Canyon was cut by the Colorado crossing the Kaibab upwarp, on which there is no evidence of movement after the Paleocene, and K-Ar dating of basalts along the lower Colorado proves that the river began to flow through its present outlet, in Grand Wash Cliffs, no more than 10 m.y. ago. If, as Hunt postulates, a major through-flowing stream was draining the southern Plateau before this, it must have had another outlet. The abandoned channel near Peach Springs was proposed, but contains the wrong sediments. According to the capture hypothesis of McKee et al., drainage from the northern Plateau was separated by the upwarp from local drainage along fault zones. Tilting led to ponding, following which the Colorado found its modern outlet by capture by the Hualapai. Hunt's hypothesis has impounded water from the Colorado seeping through limestone and emerging as springs from Grand Wash Cliffs. — ESL

04782 **Brenden, B. B.; Neeley, V. I.; Garlick, G. F.** Borehole seismics multiply drill data: Eng. and Mining Jour., v. 171, no. 2, p. 93-96, illus., 1970.

Acoustic transducers convert electrical signals into acoustic energy which propagates through the rock, and is reflected from anomalies. The reflected sound energy is converted to electrical signals, the amplitude of which, and the elapsed time between generation and reception, are accurately measured. This information is processed to produce raw data for mapping anomalies, which may be interpreted to indicate faults and mineralized zones. Two types of loss limit the range of this system: (1) because reflected energy decreases inversely as the square of the distance, or as the inverse fourth power, if the object is a small diffuse reflector, and (2) because of the absorption of acoustical energy in the rock. An illustration of the technique to establish complete orientation and mapping information from a single drill hole is given. Output from a Fortran program indicates fault planes with dip and strike data, and thickness of mineralized zones. — ESL

04714 **Bretsky, Peter W.; Bermingham, John J.** Ecology of the Paleozoic scaphopod genus *Plagioglypta* with special reference to the Ordovician of eastern Iowa: Jour. Paleontology, v. 44, no. 5, p. 908-924, illus., tables, 1970.

Small conical tubes found in the Late Ordovician basal Maquoketa Formation in eastern Iowa are identified as *Plagioglypta iowaensis* (James) and are considered the first unquestioned pre-Mississippian scaphopods. This determination is based on morphological considerations and on comparison of the basal Maquoketa environmental setting with those in which late Paleozoic scaphopods, especially *Plagioglypta*, are locally abundant. — JWH

Bricker, Owen P. *See* Cleaves, Emery T. 04877

04967 **British Columbia Department of Mines.** (and Petroleum Geology). Geology, exploration, and mining in British Columbia, 1969: Vancouver, B.C., British Columbia Dept. Mines and Petroleum Geology, 466 p., illus., tables, 1970.

Reports of metal mines in British Columbia are grouped by mining divisions of the province; geologic descriptions of some areas and mines are included. Geological, geophysical, and geochemical reports credited for assessment are tabulated. Information is given also on placers, structural materials and industrial minerals, and coal. — MCM

05071 **Brochu, Michel.** Teneur en quartz filonien et minéralisation au Québec, au Labrador et dans le Nord-Est de l'Arctique canadien [Percentage of vein quartz and mineralization in Quebec, in Labrador and into the northeastern Canadian Arctic (with English abs.)]: Cahiers Géol., no. 86, p. 1090-1127, tables, 1970.

The value of vein quartz is expressed by two indexes; that of detrital or clastic quartz (I.Q.d) is the percentage of vein quartz among the pebbles of a given clastic formation or sediment; the second, a substratum index (I.Q.r., index of quartz in rock in place), is the value, in decimeters, of vein quartz intersected on a 10-m linear profile. Laboratory measurements have been done on samples from northeastern Canada; field measurements have also been conducted. In granitic-gneissic and limestone areas, the median quartz index is O, and reaches slightly higher values in crystallophyllian rocks and composite lithology. A comparison is established between quartz indexes and regional values of dips in sexagesimal grades, and the microtectonic index. The value of indexes of vein quartz increases parallel to these variables. The value of statistical observations on quartz of vein origin as a potential guide to mineralized bodies is suggested. — ESL

04511 **Bromfield, Calvin S.; Baker, Arthur A.; Crittenden, Max D., Jr.** Geologic map of the Heber quadrangle, Wasatch and Summit Counties, Utah: U.S. Geol. Survey Geol. Quad. Map GQ-864, scale 1:24,000, sections, 1970.

04494 **Brook, R. P., Jr.** (compiler). Ira Rinehart's 1969 structure maps of new Texas oil-gas fields: Dallas, Tex., Rinehart Oil News, 184 p., illus., 1970.

04549 **Brooke, J.; Pelletier, B. R.** Sea drilling techniques of the Bedford Institute: Underwater Sci. and Technology Jour., v. 2, no. 3, p. 165-167, illus., 1970.

This paper describes methods used to obtain oriented cores of hard rock material from the ocean floor in depths ranging from tidal flats to 1800 m. Two different drill units have been developed by the Bedford Institute [Nova Scotia], each covering a specific range of depth and each powered by a different energy source. Both units have been used to obtain cores from areas of the ocean floor, and the deeper range drill unit has retrieved cores from areas that have previously not been accessible. — Authors' abstract

05017 **Breakins, D. G.; Spooner, C. M.** The isotopic ages of the Oak Point and Stonington granites, eastern Penobscot Bay, Maine: Jour. Geology, v. 78, no. 5, p. 570-576, illus., tables, 1970.

To test the reliability of the previous K-Ar dates and the field relationships, Rb-Sr whole-rock analyses have been determined for the Oak Point and Stonington granites with the following results: Oak Point granite, $t = 357 \pm 1$ m.y. with initial Sr (87/86) $= 0.7045 \pm 0.0001$; Stonington granite, $t = 341 \pm 21$ m.y. with initial Sr (87/86) $= 0.7050 \pm 0.0006$. Although the analytical uncertainties overlap, the data suggest that

the Stonington granite is slightly younger than the Oak Point granite and, on the basis of their initial ratios, that both were derived from the same parent magma. Further, the reliability of previously published K-Ar dates on the biotites is confirmed. — JCR

04770 **Broussard, Francis A.** Mamou Field, Evangeline Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 18-18c, illus., 1970.

04635 **Brown, Donald.** Instrumentation on the 'Gulfrex': UnderSea Technology, v. 11, no. 10, p. 16-17, 20, 24, illus., 1970.

Gulf Research and Development Company outfitted a fishing trawler, the 'Gulfrex', to conduct research and development on marine exploration methods and equipment, data reduction and interpretation, and also to investigate the geology of the water-covered continental margins. This article describes the equipment on the ship: computerized integrated navigational systems, a Redcor digital seismic system, which amplifies and records reflected acoustic waves, a Varian proton-precession magnetometer, a gravimeter, and an underwater oil- or gas-seep detector or 'Sniffer'. Two onboard computers process and interpret data. — EH

05128 **Brown, John S.** Mississippi Valley type lead-zinc ores — A review and sequel to the "Behre Symposium" [with French abs.]: Mineralium Deposita, v. 5, no. 2, p. 103-119, illus., tables, 1970.

Conclusions of contemporary workers on ores show North American opinion converging toward a dominantly connate marine, but epigenetic ore fluid with probably minor additions from deeper sources; fluid inclusions are taken as a reliable index of the ore solution's nature. European opinion is divided between proponents of syngenesis-diagenesis, and of magmatic-epigenetic origin, a third contingent, mainly French, supporting hydatogenesis based on deeply circulating meteoric water. The author evaluates these hypotheses, emphasizing the basis for the North American concept, and points out weaknesses in the syngenetic-diagenetic explanation. Probability of hybrid sources for both American and European deposits is offered as a solution to the typically J- and B-type anomalies of lead isotope composition. — *from* Author's abstract

04553 **Brown, Roger J. E.** Permafrost in Canada, its influence on northern development: Toronto, Ontario, Canada, Univ. Toronto Press, 234 p., illus., 1970.

Brummer, J. J. *See* Karup-Möller, S. 05122

04651 **Brune, James N.** Tectonic stress and the spectra of seismic shear waves from earthquakes: Jour. Geophys. Research, v. 75, no. 26, p. 4997-5009, illus., table, 1970.

An earthquake model has been derived by considering the effective stress available to accelerate the sides of the fault. The model describes the near- and far-field displacement time function and spectrum and includes the effects of fractional stress drop. The model successfully explains near- and far-field spectra observed for earthquakes and indicates that the effective stresses operating during earthquakes are of the order of 100 bars. The results obtained in this study may be used to estimate effective stress, stress drop, and source dimensions by comparing observed seismic spectra with the theoretical spectra. — Author's conclusions

04492 **Buerger, Martin J.** Contemporary crystallography: New York, McGraw-Hill Book Co., 364 p., illus., tables, 1970.

The book is written for the student who wants to know something of the characteristic features of crystals; it specifically outlines the theory and results concerned with basic geometrical features of crystals, and modern methods of experimentally determining this geometry. — MCM

04568 **Butler, Godfrey P.** Secondary anhydrite from a sabkha, northwest Gulf of California, Mexico, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 153-155, illus., 1970.

In an extensive sabkha in the northwestern corner of the Gulf of California, development of calcium sulfate minerals is restricted to a narrow zone at the landward margin of the supratidal flat and within the upper 10-15 cm of sediment. Anhydrite, found within the upper 5 cm, occurs as small irregular nodules and as blebs of felty crystal aggregates. In August 1968 surface temperatures of 51°C were recorded in gypsum and anhydrite sediments; temperatures at a depth of 15 cm were between 38-40°C; two samples of brine collected beneath the evaporites had chlorinities of approximately 143 and 145 per mil. Comparison of the calcium sulfate mineral assemblage, brine chlorinity and strontium content of coexisting gypsum and anhydrite with that of similar data from a sabkha in the Arabian Gulf suggests the anhydrite is a secondary mineral after early diagenetic gypsum. — *from* Author's abstract

04473 **Caldwell, John W.; Strabala, J. M.** Application of modern well logging methods to salt solution cavities, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 341-352, illus., 1970.

Two acoustical devices, the SEISCALIPER and SEISVIEWER, have been introduced to the field recently and have applications in solution mined cavities. The SEISCALIPER consists of a downhole acoustic scanner-transceiver unit run from standard logging cable with its associated surface control display. The system is designed to provide accurate mapping and orientation of solution-filled cavities. Additional detailed information of the roof and floor may be obtained by the use of multiple selected transducers. Profiles of the cavity, along magnetic bearings, are developed in addition to computerized calculations of volumes for the entire cavity. The SEISVIEWER produces a high resolution acoustic picture of the borehole or casing wall in any type of fluid. Acoustic pictures clearly define fractures, casing splits, pitting and perforations. — Authors' abstract

Callo, A. J. *See* Simmons, Gene. 05103

05081 **Cameron, A. G. W.** Formation of the Earth-Moon system: EOS, v. 51, no. 9, p. 628-633, illus., 1970.

Support is given to Ringwood's theory that the Moon was formed by condensation from a hot extended silicate atmosphere of the primitive Earth. A model for the primordial solar nebula is presented which has two solar masses and flattens into a disk structure from which the Sun and planets formed by condensation, triggered by the differential rotation of the disk. The original form of the Earth would have been a high temperature body (10^4 °K) of 5 to 10 times its present radius, formed by the collision between two bodies of comparable mass condensed from the still-present solar nebula. Since a body of this size and angular momentum would be rotationally unstable beyond three Earth radii, solid bodies could accumulate and stick together beyond this point. It is suggested that the Moon accumulated here in the Earth's equatorial plane from the silicate envelope encircling the "planet," and that as both bodies cooled and condensed, the present solid bodies formed from these gaseous ones. The many implications of this theory are discussed. — GV

04900 **Cameron, Cornelia C.** Peat deposits of southeastern New York: U.S. Geol. Survey Bull. 1317-B, p. B1-B32, illus., tables, 1970.

Investigations of 66 undeveloped peat deposits, estimated at 11,500,000 short tons of air-dried peat, mostly of good quality reed-sedge type, have revealed that physical characteristics of peat and geologic settings of the deposits can be used as guides to peat resources. Water-holding capacity of peat in the deposits tends to increase as the percentage of fiber greater than 0.15 mm in length increases. Fiber content and percentage of organic material is inversely proportional to the degree of diagenesis of the peat. Analyses show that ash content is related to the shape of the basin of accumulation, to the distribution of the unconsolidated material, and to the rocks that compose the depression walls. — CCC

04929 **Campbell, Ian A.** Erosion rates in the Steveville Badlands, Alberta [with French abs., p. 269]: Canadian Geographer, v. 14, no. 3, p. 202-216, illus., tables, 1970.

This study on the processes of sedimentation made in 1968 in the Steveville Badlands, Alberta, indicates rates of erosion comparable to those of similar regions in the United States. Runoff plots, each with rain gauges, were used to correlate sedimentation rates with precipitation amounts. The study reveals annual erosion rates in excess of 1.7 acre-feet per square mile, which gives an average denudation rate of approximately three feet per thousand years. — Author's abstract

04489 **Campbell, J. F.; Coulbourn, W. T.; Moberly, R., Jr.; Rosendahl, B. R.** Reconnaissance sand inventory, off leeward Oahu: Hawaii Inst. Geophysics [Rept.] HIG-70-16, 14 p., illus., tables, 1970.

The southern and western coasts of Oahu have been surveyed for shallow-water sand bodies, using a seismic reflecting technique. Sand bodies discovered and mapped in water depths of between 60 and 300 feet contain about 370 million cubic yards of sand. Samples from a few locations were fine-grained calcareous sand that was similar to, but finer than, most Hawaiian beach sands. The reconnaissance survey points to several localities where detailed sampling and mapping are warranted. — Authors' abstract

Campbell, J. F. *See* Furumoto, A. S. 04925

05131 **Canada Geological Survey.** Aeromagnetic series, Toronto, Ontario: Canada Geol. Survey Geophysics Paper 7334, scale 1:253,440, 1970.

05132 **Canada Geological Survey.** Aeromagnetic series, Kitchener, Ontario: Canada Geol. Survey Geophysics Paper 7335, scale 1:253,440, 1970.

05133 **Canada Geological Survey.** Aeromagnetic series, Bruce, Ontario: Canada Geol. Survey Geophysics Paper 7341, scale 1:253,440, 1970.

05134 **Canada Geological Survey.** Aeromagnetic series, Tichborne, Ontario: Canada Geol. Survey Geophysics Paper 8380, scale 1:63,360, 1970.

05135 **Canada Geological Survey.** Aeromagnetic series, Westport, Ontario: Canada Geol. Survey Geophysics Paper 8381, scale 1:63,360, 1970.

05136 **Canada Geological Survey.** Aeromagnetic series, Brockville, Ontario: Canada Geol. Survey Geophysics Paper 8382, scale 1:63,360, 1970.

05137 **Canada Geological Survey.** Aeromagnetic series, Port Elgin, Ontario: Canada Geol. Survey Geophysics Paper 8383, scale 1:63,360, 1970.

05138 **Canada Geological Survey.** Aeromagnetic series, Markdale, Ontario: Canada Geol. Survey Geophysics Paper 8384, scale 1:63,360, 1970.

05139 **Canada Geological Survey.** Aeromagnetic series, Collingwood, Ontario: Canada Geol. Survey Geophysics Paper 8385, scale 1:63,360, 1970.

05140 **Canada Geological Survey.** Aeromagnetic series, Barrie, Ontario: Canada Geol. Survey Geophysics Paper 8386, scale 1:63,360, 1970.

05141 **Canada Geological Survey.** Aeromagnetic series, Beaverton, Ontario: Canada Geol. Survey Geophysics Paper 8387, scale 1:63,360, 1970.

05142 **Canada Geological Survey.** Aeromagnetic series, Lindsay, Ontario: Canada Geol. Survey Geophysics Paper 8388, scale 1:63,360, 1970.

05143 **Canada Geological Survey.** Aeromagnetic series, Peterborough, Ontario: Canada Geol. Survey Geophysics Paper 8389, scale 1:63,360, 1970.

05144 **Canada Geological Survey.** Aeromagnetic series, Campbellford, Ontario: Canada Geol. Survey Geophysics Paper 8390, scale 1:63,360, 1970.

05145 **Canada Geological Survey.** Aeromagnetic series, Tweed, Ontario: Canada Geol. Survey Geophysics Paper 8391, scale 1:63,360, 1970.

05146 **Canada Geological Survey.** Aeromagnetic series, Sydenham, Ontario: Canada Geol. Survey Geophysics Paper 8392, scale 1:63,360, 1970.

05147 **Canada Geological Survey.** Aeromagnetic series, Gananoque, Ontario: Canada Geol. Survey Geophysics Paper 8393, scale 1:63,360, 1970.

05148 **Canada Geological Survey.** Aeromagnetic series, Mallorytown, Ontario: Canada Geol. Survey Geophysics Paper 8394, scale 1:63,360, 1970.

05149 **Canada Geological Survey.** Aeromagnetic series, Durham, Ontario: Canada Geol. Survey Geophysics Paper 8395, scale 1:63,360, 1970.

05150 **Canada Geological Survey.** Aeromagnetic series, Dundalk, Ontario: Canada Geol. Survey Geophysics Paper 8396, scale 1:63,360, 1970.

05151 **Canada Geological Survey.** Aeromagnetic series, Alliston, Ontario: Canada Geol. Survey Geophysics Paper 8397, scale 1:63,360, 1970.

05152 **Canada Geological Survey.** Aeromagnetic series, Newmarket, Ontario: Canada Geol. Survey Geophysics Paper 8398, scale 1:63,360, 1970.

05153 **Canada Geological Survey.** Aeromagnetic series, Scugog, Ontario: Canada Geol. Survey Geophysics Paper 8399, scale 1:63,360, 1970.

05154 **Canada Geological Survey.** Aeromagnetic series, Rice Lake, Ontario: Canada Geol. Survey Geophysics Paper 8400, scale 1:63,360, 1970.

05155 **Canada Geological Survey.** Aeromagnetic series, Trenton, Ontario: Canada Geol. Survey Geophysics Paper 8401, scale 1:63,360, 1970.

05156 **Canada Geological Survey.** Aeromagnetic series, Belleville, Ontario: Canada Geol. Survey Geophysics Paper 8402, scale 1:63,360, 1970.

05157 **Canada Geological Survey.** Aeromagnetic series, Bath, Ontario: Canada Geol. Survey Geophysics Paper 8403, scale 1:63,360, 1970.

05158 **Canada Geological Survey.** Aeromagnetic series, Palmerston, Ontario: Canada Geol. Survey Geophysics Paper 8404, scale 1:63,360, 1970.

05159 **Canada Geological Survey.** Aeromagnetic series, Orangeville, Ontario: Canada Geol. Survey Geophysics Paper 8405, scale 1:63,360, 1970.

05160 **Canada Geological Survey.** Aeromagnetic series, Bolton, Ontario: Canada Geol. Survey Geophysics Paper 8406, scale 1:63,360, 1970.

05161 **Canada Geological Survey.** Aeromagnetic series, Markham, Ontario: Canada Geol. Survey Geophysics Paper 8407, scale 1:63,360, 1970.

05162 **Canada Geological Survey.** Aeromagnetic series, Oshawa, Ontario: Canada Geol. Survey Geophysics Paper 8408, scale 1:63,360, 1970.

05163 **Canada Geological Survey.** Aeromagnetic series, Port Hope, Ontario: Canada Geol. Survey Geophysics Paper 8409, scale 1:63,360, 1970.

05164 **Canada Geological Survey.** Aeromagnetic series, Guelph, Ontario: Canada Geol. Survey Geophysics Paper 8410, scale 1:63,360, 1970.

05165 **Canada Geological Survey.** Aeromagnetic series, Brampton, Ontario: Canada Geol. Survey Geophysics Paper 8411, scale 1:63,360, 1970.

05166 **Canada Geological Survey.** Aeromagnetic series, Toronto, Ontario: Canada Geol. Survey Geophysics Paper 8412, scale 1:63,360, 1970.

05167 **Canada Geological Survey.** Aeromagnetic series, Hamilton, Ontario: Canada Geol. Survey Geophysics Paper 8413, scale 1:63,360, 1970.

04503 **Caner, B.** Electrical conductivity structure in western Canada and petrological interpretation, *in* Symposium on multidisciplinary studies of unusual regions of the upper mantle, Madrid, Spain, 1969, Proc.: Jour. Geomagnetism and Geoelectricity, v. 22, nos. 1-2, p. 113-129, illus., 1970.

An integrated approach using both geomagnetic depth-sounding (GDS) and magnetotellurics (MT) is applied to determination of the electrical conductivity structure in western Canada; 42 GDS stations and 6 broad-band MT stations are used. These data are combined with other geophysical information to provide self-consistent petrological models. Excluding geochemically improbable solutions, it can be shown that: (a) temperatures at depth 35 km must be at least 750°C in the entire western region (eastwards extent undefined); (b) in a smaller, sharply defined, region (eastern boundary within about ± 50 km of the Rocky Mountain Trench) the lower crust and possibly uppermost 10-25 km of the mantle are hydrated, probably with partial melting. — Author's abstract

04464 **Cannon, W. F.; Gair, J. E.** A revision of stratigraphic nomenclature for middle Precambrian rocks in northern Michigan: Geol. Soc. America Bull., v. 81, no. 9, p. 2843-2846, illus., 1970.

The name Marquette Range Supergroup is proposed to supplant the term Animikie Series for middle Precambrian strata of the Northern Peninsula of Michigan and adjacent areas of Wisconsin. The Marquette Range Supergroup consists of the Chocolay, Menominee, Baraga, and Paint River Groups. Although equivalence of the Animikie Group in Ontario and Minnesota with parts of the Michigan rocks is likely, the stratigraphic complexity of the Michigan sequence requires supergroup rank. The inherent confusion of an Animikie Group in Ontario and Minnesota, and an Animikie Supergroup in Michigan, makes a local name such as Marquette Range Supergroup preferable for middle Precambrian rocks of Michigan. — *from* Authors' abstract

04623 **Capon, Jack.** Analysis of Rayleigh-wave multipath propagation at LASA: Seismol. Soc. America Bull., v. 60, no. 5, p. 1701-1731, illus., tables, 1970.

An investigation has been made of the multipath propagation of Rayleigh waves by using data obtained from the large aperture seismic array (LASA). The use of the LASA in conjunction with a high-resolution analysis technique provides a greater angular resolution and accuracy than was previously possible for the analysis of the multipath propagation. Measurements have been made of this phenomenon for the Rayleigh waves of 26 events distributed at various azimuths and distances from LASA. On the basis of these measurements reasonably good conjectures are made concerning the actual propagation paths for groups in the 20- to 40-sec period range. It is shown that in almost all cases these propagation paths can be associated with refractions and reflections at the continental margins. — Author's abstract

04690 **Carr, W. J.; Quinlivan, W. D.; Gard, L. M., Jr.** Age and stratigraphic relations of Amchitka, Banjo Point, and Chitka Point Formations, Amchitka Island, Aleutian Islands, Alaska, *in* Changes in stratigraphic nomenclature by the U.S. Geological Survey, 1969: U.S. Geol. Survey Bull. 1324-A, p. A16-A22, illus., tables, 1970.

Carrier, W. D. *See* Scott, R. F. 05110

Carriveau, A. R. *See* Duke, C. M. 04667

Carter, C. *See* Churkin, M., Jr. 05004

04530 **Carter, N. C.** Copper and molybdenum porphyry deposits in central British Columbia: Canadian Mining Jour., v. 91, no. 4, p. 74-76, 1970.

In 1969 British Columbia's mineral production attained a record of 460 million dollars, with copper and molybdenum contributing about 60 percent. Search for

porphyry-type copper and molybdenum deposits has been active in the area bounded on the west and east by plutonic rocks of the Coast Crystalline and Omineca tectonic belts, intrusive into Mesozoic rocks. Two open-pit mines are in the area, copper at Babine Lake, and molybdenum at Alice Arm. Porphyry copper deposits occur in the east, porphyry deposits containing copper and molybdenum in the central part, and porphyry molybdenum in the west. Quartz monzonite porphyry is the dominant rock type in mineralized intrusives. Hornfels forms an aureole up to 1,000 feet out from the stock or plug. Hydrothermal alteration also occurs within the intrusives. Ore minerals include chalcopyrite, bornite, and molybdenite. — ESL

04741 **Carter, Neville L.; Heard, Hugh C.** Temperature and rate dependent deformation of halite: Am. Jour. Sci., v. 269, no. 3, p. 193-249, illus., tables, 1970.

Extrapolation of experimental results to the lower rates of natural deformation in halite bodies indicates that any translation gliding should take place by {110}<110> slip. However, under conditions expected for the growth of salt domes, self-diffusion is probably the rate-limiting process. Observations by others on grain shapes and fabrics of polycrystalline halite from two salt domes are interpreted to indicate that the halite deformed predominantly either by syntectonic recrystallization or by strong plastic deformation followed by annealing recrystallization. The flow equation for polycrystalline halite, is, therefore, expected to indicate that strain rates and equivalent viscosities are very stress sensitive; the viscosities should be little affected by temperature. — *from* Author's abstract

04630 **Cavender, Ted M.; Lundberg, John G.; Wilson, Richard L.** Two new fossil records of the genus *Esox* (Teleostei, Salmoniformes) in North America: Northwest Sci., v. 44, no. 3, p. 176-183, illus., 1970.

A fossil palatine found in the late Miocene Deer Butte Formation in Malheur County, Oregon, is most similar to that of *Esox masquinongy*. A palatine from Late Wisconsinan fluviatile deposits along the Itchtucknee River, Florida, is tentatively identified as *Esox niger*. On the basis of the specimen from Oregon, it is concluded that *Esox* can be considered one of the extinct eastern elements in the Tertiary fish fauna of the northwestern United States. — EH

04613 **Cawley, J. T.** Saskatchewan mineral development — Past, present, and future: Canadian Mining Jour., v. 91, no. 4, p. 72-74, illus., 1970.

The purpose of this paper is to discuss some of the significant developments in the mineral industry that are taking place in Saskatchewan at present. As some of these developments result from work that was carried out in the past, a brief review of the mining industry to date is given. In addition, the importance of present-day developments to the future exploration potential of the province is discussed. — Author's abstract

Cervione, Michael A., Jr. *See* Ryder, Robert B. 04536

04778 **Chadeayne, Dennis.** Tigre Lagoon Field, Vermilion Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 27-27c, illus., 1970.

Chamberlain, C. Kent. *See* Rigby, J. Keith. 04706

Chao, Pao-Chin. *See* Cruft, Edgar F. 04638

Charbonneau, B. W. *See* Darnley, A. G. 04528

04616 **Chave, Keith E.; Suess, Erwin.** Calcium carbonate saturation in seawater — Effects of dissolved organic matter: Limnology and Oceanography, v. 15, no. 4, p. 633-637, illus., tables, 1970.

Surface seawater is generally supersaturated with $CaCO_3$; but carbonate will not precipitate from natural seawater in convenient experimental times. If the supersatu-

ration is increased by the addition of Ca^{2+} or Co_3^{2-} ions, precipitation can occur in minutes or hours. Seawater, with 0.1 *m* Na_2Co_3 solution added to give a *p*H of 9.5, will begin rapid $CaCO_3$ (aragonite) precipitation in as little as 15 min. The length of time between the addition of the Na_2Co_3 and rapid precipitation increases with an increase in the dissolved organic content of the water. If $CaCl_2$, which produces no *p*H increase, is added to seawater, $CaSo_4 2H_2O$ (gypsum) is the only precipitate that will form within 12 hr. — Authors' abstract

Cheatum, Elmer P. *See* Schultz, Gerald E. 04708

04722 **Chiang, Kam.** The use of acetate peels in graptolite studies: Jour. Paleontology, v. 44, no. 5, p. 988, illus., 1970.

The acetate peel technique, which has been widely used to reproduce structures of carbonate fossils such as corals and brachiopods, can also be applied to the detailed external features of graptolites preserved in black shale or slate. The slaty cleavage surface does not require polishing and etching. The surface is washed and dried, then covered with acetone; the acetate film is immediately pressed firmly against the surface, using a stream of compressed air to remove air bubbles. The peel is removed when dry, after five to ten minutes. Photographic prints can be made directly from peels, and the contrast is usually good. — VMJ

05099 **Choate, R.** Lunar soil density as determined from Surveyor data and laboratory tests, *in* Analysis of Surveyor data: California Inst. Technology Jet Propulsion Lab. Tech. Rept. 32-1443, p. 35-65, illus., 1970.

Laboratory tests were conducted on basalt and aluminum soils similar in composition to lunar soils, in order to evaluate more accurately soil bulk density, or relative packing density, and coefficient of friction. The determination of soil bulk density is described and values of physical properties of soils are tabulated and illustrated. — JHF

05100 **Choate, R.** Lunar soil coefficient of friction determined from Surveyor data and laboratory tests, *in* Analysis of Surveyor data: California Inst. Technology Jet Propulsion Lab. Tech. Rept. 32-1443, p. 67-99, illus., 1970.

An estimate is based on 70 laboratory tests of three basalt soils at various densities. The best fit to Surveyor data provides a coefficient of friction for lunar soil of 0.35 at initial displacement, 0.72 at 2.5-cm displacement, 0.89 at 7.6-cm displacement, and 0.95 at 15.2-cm displacement, with tolerances for these values estimated at 0.05. — JHF

05101 **Choate, R.** Depths of Surveyor footpad penetrations at first impact — Their relation to the bearing strength of the lunar soil, *in* Analysis of Surveyor data: California Inst. Technology Jet Propulsion Lab. Tech. Rept. 32-1443, p. 101-124, illus., 1970.

Detailed study of Surveyor landings (seven touchdowns of the five Surveyors) indicate that the lunar soil has remarkably uniform bearing strength properties. Maximum and minimum values for bearing strength per centimeter of penetration are tabulated; averages for Surveyors I, VI, and VII are 1.70, 1.65, and 1.58 N per cm^2 per cm, respectively. — JHF

05093 **Christensen, E. M.** Lunar surface mechanical properties — Surveyor results, *in* Symposium on planetary atmospheres and surfaces, Woods Hole, Mass., 1969: Radio Sci., v. 5, no. 2, p. 171-180, illus., 1970.

Lunar surface mechanical properties have been interpreted from the interactions of five Surveyor spacecraft with the lunar surface (exclusive of the surface sampler). The lunar soil at the one highland and the four lunar mare landing sites is remarkably similar, even though these sites are widely separated. The soil is predominantly fine-grained and granular; it is estimated to have a cohesion value between 0.05 and 0.17 N per cm^2. The static bearing strength of the soil increases with depth. It is estimated that, at the surface, the strength is less than 0.1 N per cm^2; at a depth of 4 cm, for a

25-cm-diameter plate, the strength is somewhat greater than the originally estimated 4 to 6 N per cm^2. The soil, at least in the upper few centimeters, is compressible. — Author's abstract

Christensen, E. M. *See* Ko, H. Y. 05102

05117 **Christian, Louis B.** Ancient windblown terrains of central California: California Div. Mines and Geology Mineral Inf. Service, v. 23, no. 9, p. 175-179, illus., 1970.

In the Great Valley, between Bakersfield and Sacramento, are scattered remains of an ancient desert terrain. Barcan and seif dunes, now vegetated, trend northwesterly, as do blowouts, deflation hollows, and a systematically deranged drainage pattern on a surface scored by extensive prehistoric wind erosion. Their appearance is illustrated on the Arena and Turlock quadrangle topographic maps with small contour intervals. The trend of this so-called "hogwallow micro-relief" indicates ancient winds prevailing as today, but barcan orientations suggest some southeast as well as northwest winds more strongly bivectoral and seasonal than now. No carbon dating or details of stratigraphy are at hand for these features, but, from their height above the Merced River and the amount of dissection, some considerable age within the Pleistocene is postulated, perhaps related to the younger glaciation of the Sierra Nevada. — GDC

Christiansen, Robert L. *See* Pierce, Kenneth L. 04693

05004 **Churkin, M., Jr.; Carter, C.; Eberlein, G. D.** Graptolite succession across the Ordovician-Silurian boundary in south-eastern Alaska [abs.]: Geol. Soc. London Proc. 1970, no. 1663, p. 194, 1970.

04625 **Clark, Bruce R.** Mechanical formation of preferred orientation in clays: Am. Jour. Sci., v. 269, no. 3, p. 250-266, illus., tables, 1970.

Kaolin-water mixtures were subjected to (1) unidirectional compaction between opposed pistons and (2) simple measurable distortion without any change in volume or porosity. Degree of clay platelet orientation was determined from X-ray diffraction intensities. Compaction produced slightly stronger preferred orientations for the same amount of total strain, but distortion generally accounts for a far greater amount of total strain in deformed rocks. Thus, distortion, not compaction, appears to be the more significant cause of preferred orientation in deformed argillites. Maximum preferred orientations were found to be perpendicular to the greatest shortening, not parallel to the greatest shear strain. Such empirical experiments might eventually permit a quantitative determination of the amount of deformation in an argillaceous sediment from the quality of its preferred orientation. — *from* Author's abstract

04879 **Clark, Bruce R.** Origin of slaty cleavage in the Coeur d'Alene district, Idaho: Geol. Soc. America Bull., v. 81, no. 10, p. 3061-3071, illus., 1970.

Deformational features in argillaceous rocks of the Belt Supergroup indicate that the slaty cleavage was produced by mechanical reorientation of original clays during an early period of folding. This regional folding probably occurred soon after the deposition and burial of the younger units in the district. The cleavage is parallel to the axial planes of the folds in their hinges, but in the limbs it dips in the same direction as the limbs but more steeply. Motion within argillite beds between quartzite beds during folding produced dimensional preferred orientations of detrital quartz and muscovite that is not related to recrystallization due to low-grade metamorphism. — RAL

04946 **Clark, David L.** Magnetic reversals and sedimentation rates in the Arctic Ocean: Geol. Soc. America Bull., v. 81, no. 10, p. 3129-3134, illus., table, 1970.

Major reversals of the Earth's magnetic field have left a good record in sediment cores taken from ice-island T-3 in the Arctic Ocean. Times of major magnetic reversals, such as the Brunhes-Matuyama boundary, can be correlated with radiometric

age determinations, and from this figure sedimentation rates can be calculated. These sedimentation rates may be used to calculate and identify times of other magnetic events in contrast to magnetic noise in the cores. The reliability of this can be checked by comparison with the magnetic standard that is based on radiometric determinations. Minor magnetic events (including the Blake, Jaramillo and others in the Matuyama and Gauss Epochs) can be identified in the cores. Color is a good stratigraphic indicator, as well, and certain sediment types have widespread distribution in the 100 cores studied. [Sedimentation rates range from 0.8 to 5 mm/1000 yr in the area studied.] — Author's abstract

04905 **Clark, Robey H.** Closed system for generation and entrapment of hydrocarbons in Cenozoic deltas, Louisiana gulf coast [abs.]: Corpus Christi Geol. Soc. Bull., v. 11, no. 1, p. 2-3, 1970.

Clayton, R. N. *See* Schwarcz, H. P. 04650

04877 **Cleaves, Emery T.; Godfrey, Andrew E.; Bricker, Owen P.** Geochemical balance of a small watershed and its geomorphic implications: Geol. Soc. America Bull., v. 81, no. 10, p. 3015-3032, illus., tables, 1970.

Pond Branch drains 95 forested acres in Maryland. During two years of study, chemical solution removed five times as much material as mechanical transport. In the long term, the chemical-mechanical balance probably is about 1:1. Weathering of oligoclase and biotite releases most of the dissolved solids measured in outflow from the basin; base flow removes about 90 percent of total effluent load; silica, sodium, and bicarbonate are the dominant constituents. Chloride and sulfur are introduced mostly by precipitation; chloride moves through the system undiminished, but part of the sulfur is incorporated in the biomass. Other constituents in runoff are contributed largely by rock weathering. Displaced soil moisture and interflow are major contributors. — JHF

Clements, J. R. *See* Cook, J. C. 04474

Clews, D. Richard. *See* Bradshaw, Peter M. D. 04663

Clews, D. Richard. *See* Bradshaw, Peter M. D. 04672

04932 **Cloud, Preston E., Jr.** Älteste Zellkern-Mikroorganismen 1,2 bis 1,4 Milliarden Jahre alt! [The oldest eucaryote microorganisms 1.2 to 1.4 billion years old!]: Umschau, v. 70, no. 5, p. 150-151, illus., 1970.

Eucaryotes identified in the microfauna of the Crystal Spring Formation of southeastern California represent the oldest known evidence of the transition from a procaryotic to a mitosing cell. Two types are distinguished, resembling chlorophycean and chrysophycean algae respectively. A pre-Paleozoic age is inferred for the enclosing rocks by correlation with similar radiometrically dated rocks in Arizona and with stromatolites of California. — MS

04734 **Clowes, R. M.; Kanasewich, E. R.** Seismic attenuation and the nature of reflecting horizons within the crust: Jour. Geophys. Research, v. 75, no. 32, p. 6693-6705, illus., 1970.

Near-vertical incidence deep-reflection seismograms recorded in southern Alberta are used to investigate crustal characteristics, aided by synthetic seismograms with frequency- and depth-dependent attenuation. Comparison of autopower spectrums of selected time intervals on field records with theoretically computed spectrums is an effective means of constructing models of the seismic properties of the lower crust. The Q model thus obtained for Alberta is not unique; it requires considerable variation in the upper 2 km with an average of 300, and a value of 1,500 in the lower 40 km and a probable increase with depth. Velocity-depth models of reflectors in the basal 15 km of crust are constructed. The only model that satisfies most of the observational data is one having a transition zone less than 1 km thick composed of thin sills (less than 0.2 km thick) of alternating high- and low-velocity material. — DBV

04938 **Coffeen, J. A.** How to migrate seismic dips: Oil and Gas Jour., v. 68, no. 45, p. 125-128, 132-134, illus., 1970.

A seismic reflection from a bed tilted more than about 10° must be geometrically replotted to place the bed in its correct subsurface position. Replotting, or migrating, can be accomplished manually by using one of several devices. This paper describes the use of plotting arm, beam compass, double arm, wave front chart and migrating bar (a new device) for migrating in two dimensions. An electronic computer may be used to migrate dips when there are large amounts of data. Corrections for velocity changes, three-dimensional migration and methods used to detect certain types of subsurface features are also discussed. — WBC

04694 **Cohee, G. V.; Bates, R. G.; Wright, W. B.** Changes in stratigraphic nomenclature by the U.S. Geological Survey, 1969: U.S. Geol. Survey Bull. 1324-A, p. A1-A41, illus., 1970.

Stratigraphic names adopted, revised, reinstated, or abandoned are listed alphabetically in a table. The age of the unit, the revision, the area involved, the author's name, and the date of publication of the report are given for each name. Following the table, short papers (cited separately) deal with: newly named and revised formations of Tertiary age on Amchitka and Rat Islands in the western Aleutian Islands, Alaska; newly named granitic rock in the Piedmont province of southwestern North Carolina and northwestern South Carolina; newly named metadiabase sills in the Negaunee Iron-Formation, Michigan; and a newly named formation of Pleistocene age in Yellowstone National Park, Wyoming. — GVC

04815 **Coldwell, Charles H.** Charles Herbert Row (1895-1970): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 9, p. 1758-1759, portrait, 1970.

04658 **Cole, W. Storrs; Applin, Esther R.** Analysis of some American Upper Cretaceous larger Foraminifera: Bulls. Am. Paleontology, v. 58, no. 258, p. 39-80, illus., 1970.

Nine species of Upper Cretaceous larger Foraminifera are discussed, and illustrated. Seven of these are from wells in peninsular Florida of which *Chubbina macgillavryi*, *Smoutina cruysi*, *Omphalocyclus* (*Torreina*) *torrei*, and *Sulcorbitoides pardoi* were not previously known to occur in the subsurface Upper Cretaceous of Florida. Specimens from a well in Florida referred to *Lepidorbitoides nortoni* by Cole are considered to be *Pseudorbitoides trechmanni*. *Orbitocyclina nortoni* is demonstrated to be a junior synonym of *Lepidorbitoides minima*. *Sulcoperculina dickersoni*, *Pseudorbitoides israelskii*, and *Vaughanina cubensis* are reevaluated. Previous studies of the occurrence of Upper Cretaceous larger Foraminifera in the southern United States are reviewed and certain tentative stratigraphic conclusions are given. — *from* Authors' abstract

05038 **Collinson, David W.** Paleomagnetism and continental drift, [Chap.] 2 *in* The megatectonics of continents and oceans (Helgi Johnson and Bennett L. Smith, editors): New Brunswick, N. J., Rutgers Univ. Press, p. 13-23, illus., 1970.

The paleomagnetic method and the interpretation of results, particularly in its application to continental drift are outlined, and the validity of the basic assumptions inherent in these interpretations are considered. Paleomagnetic observations to date show overall internal consistency at least as far back as Cambrian times, and strongly suggest polar wandering and continental drift. Dating uncertainties in Precambrian make interpretation for that era difficult. — VSN

04821 **Conatser, W. E.** Grand Isle, barrier island in Gulf of Mexico [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1783, 1970.

Conkin, Barbara M. *See* Conkin, James E. 04515

04515 **Conkin, James E.; Conkin, Barbara M.; Sawa, Takashi; Kern, John M.** Middle Devonian *Moellerina greenei* Zone and suppression of the genus *Weikkoella* Summerson, 1958: Micropaleontology, v. 16, no. 4, p. 399-406, illus., 1970.

Weikkoella Summerson, 1958, described from the Columbus Limestone of central Ohio as an arenaceous foraminiferal genus, is based on siliceous steinkerns of the oospores of the charophyte gyrogonites referable to *Moellerina greenei* Ulrich, 1886. *M. greenei* is found in the Middle Devonian Columbus Limestone of Ohio in the E, F, G, and H Zones of Stauffer (1909). In southern Indiana and northwestern Kentucky the *Brevispirifer gregarius* Zone of the definitely Onondagan portion of the Middle Devonian Jeffersonville Limestone and the new *M. greenei* Zone coincide, but in Ohio *M. greenei* ranges higher than *B. gregarius* which does not occur in the H Zone. The orientation of the gyrogonites of *Moellerina greenei* is reinterpreted on the basis of definitive apical and basal structures as determined by a study of the oogonia of modern charophytes. — Authors' abstract

04742 **Connally, G. Gordon.** Discussion — Caribou and Paleoindian in New York State, a presumed association [of paper by R. E. Funk, D. W. Fisher, and E. M. Reilly, 1970]: Am. Jour. Sci., v. 269, no. 3, p. 314-315, 1970.

For original paper, *see* Funk, Fisher, and Reilly, ibid., v. 268, no. 2, p. 181-186, 1970; Abs. North American Geology, September 1970.

Conrad, Charles, Jr. *See* Bean, Alan L. 05105

04814 **Cook, Carroll L.** Lyman Coleman Reed (1900-1970): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 9, p. 1758, portrait, 1970.

04474 **Cook, J. C.; Clements, J. R.** NQR borehole logging for evaporite minerals, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 353-356, illus., 1970.

The nuclear quadrupole moments of B^{11}, K^{39}, N^{14}, Li^{7}, Br^{81}, Na^{23}, and Cl^{35}, provide a new means by which these naturally occurring elements can be detected in solid compounds. The detection process is simple, requiring only the measurement of electromagnetic resonance-absorption or resonance-decay effects in the appropriate region of the radio-frequency spectrum. For example, the four principal resonances of boron in the mineral kernite (Na_2, B_4, O_7, H_2O) lie near 0.46 mc. and 1.9 mc. The NQR method is well suited to the detection and measurement of light elements, and a technique of borehole logging in evaporites is proposed. Typical laboratory detecting equipment and results on nitrogen compounds are briefly described. — Authors' abstract

04477 **Cook, John C.** Electromagnetic exploration within salt domes, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 386-390, illus., 1970.

Delineation of the boundaries and of seepages in large salt masses from within by electromagnetic means should be feasible, because of the expected transparency of the salt to the longer RF wave lengths. Two methods of internal exploration are here proposed and explained: permittivity logging in dry or oil-filled drill holes, and VHF radar surveys from mined openings. — Author's abstract

04888 **Cooke, C. Wythe.** Quaternary terraces of the Ouachita Valley — Discussion [of 'Origin and chronologic significance of Late Quaternary terraces, Ouachita River, Arkansas and Louisiana' by R. T. Saucier and A. R. Fleetwood, 1970]: Geol. Soc. America Bull., v. 81, no. 10, p. 3167-3169, table, 1970.

For the paper under discussion *see* ibid., v. 81, no. 3, p. 869-890, 1970; Abs. North American Geology, September 1970.

04889 **Cooke, C. Wythe.** Carolina Bays — Discussion [of 'Carolina Bays in Horry and Marion Counties, South Carolina' by B. G. Thom, 1970]: Geol. Soc. America Bull., v. 81, no. 10, p. 3171, 1970.

For the paper under discussion *see* ibid., v. 81, no. 3, p. 783-813, 1970; Abs. North American Geology, September 1970.

Cooper, Fred G. *See* Kessler, L. G., 2d. 04827

Cooper, Laurence C. *See* Smith, Clay T. 04856

04720 **Cooper, R. A.** Tectonic distortion of a syntype of *Isograptus forcipiformis latus* Ruedemann: Jour. Paleontology, v. 44, no. 5, p. 980-983, illus., table, 1970.

The only remaining syntype of *Isograptus forcipiformis latus* Ruedemann, 1947 [Lower Ordovician, Arkansas] has been tectonically distorted. The relative shortening ratio, 0.58 to 1, has been determined graphically from other fossils in the same slab; the direction of relative shortening is approximately normal to the long axis of the rhabdosome. The method for analysing distortion is outlined. The dedistorted fossil is illustrated, but its size is only approximately known. — Author's abstract

Copeland, Robert R. *See* Bates, Fred W. 04757

04747 **Coppock, Ray.** (editor). Research on water quality: California Univ. Water Resources Center Rept. 19, 36 p., 1970.

This report gives a brief overview, as of mid-1970, of the University of California's research involving water quality. One of the five sections is devoted to drainage and ground-water quality. — MCM

Costes, N. C. *See* Scott, R. F. 05110

Coulbourn, W. T. *See* Campbell, J. F. 04489

04452 **Cowan, Darrel S.; Mansfield, Charles F.** Serpentinite flows on Joaquin Ridge, southern Coast Ranges, California: Geol. Soc. America Bull., v. 81, no. 9, p. 2615-2628, illus., 1970.

Flows of serpentinite, resembling debris-flow deposits and solidified lava flows, extend downslope more than 1.5 km from the northeastern margin of a large source body of serpentinite on Joaquin Ridge, western Fresno County. Source body consists of almost completely serpentinized peridotite in fault contact with surrounding Franciscan metamorphic rocks and upturned Upper Cretaceous Panoche Group. Topographic position and surface morphology indicate flows of several ages. Flows are of rounded blocks of serpentinized peridotite in a matrix of flaky, intensely sheared serpentine, features that are strikingly similar to those of source serpentinite body. Calculations indicate that the sheared serpentinite of the flows had a low shear strength of 1 bar at atmospheric pressure and surface temperatures suggesting the serpentinites along thrusts in California could be emplaced at modest stresses and temperatures. — RAL

04546 **Cox, Allan.** Latitude dependence of the angular dispersion of the geomagnetic field: Royal Astron. Soc. Geophys. Research Jour., v. 20, no. 3, p. 253-269, illus., tables, 1970.

Changes in the direction of the Earth's magnetic field at a given site are produced in part by wobble of the main geomagnetic dipole, in part by fluctuations in the intensity and direction of the non-dipole field, and in part by changes in the intensity of the main dipole field. These three processes combine to produce an angular variance that is strongly latitude dependent. A method is presented for isolating the contribution due to variation with latitude of the average intensity of the non-dipole field. — Author's summary

04529 **Craig, D. B.; Kelly, J. A.** A critical review of northern mineral potential: Canadian Mining Jour., v. 91, no. 4, p. 76, 93-98, illus., tables, 1970.

The potential of metallic and industrial mineral deposits and prospects of northern Canada is reviewed. Rocks of the Precambrian Shield are host to gold, uranium, and silver, as well as copper, nickel, lead, and zinc. Sedimentary rocks contain the Snake River iron deposits in the Yukon and Northwest Territories, and large lead-zinc deposits of the Pine Point area. The Cordillera is important in British Columbia and

probably will be in the Yukon. Producing mines, mining development, prospects, and current exploration in Yukon and Northwest Territories, are discussed. — ESL

Cridland, Arthur A. *See* Mastrogiuseppe, Joy D. 04926

Crittenden, Max D., Jr. *See* Bromfield, Calvin S. 04511

04638 **Cruft, Edgar F.; Chao, Pao-Chin.** Nucleation kinetics of the gypsum-anhydrite system, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 109-118, illus., tables, 1970.

It has never been clearly established under what conditions, if any, anhydrite can occur as a primary precipitate. Marked inconsistencies are due primarily to metastability of gypsum which precipitates readily outside its own stability field; nucleation kinetics normally favor gypsum as a primary phase. Conditions of high supersaturation can be shown to induce nucleation and growth of anhydrite rather than metastable gypsum; nucleation kinetics are not appreciably affected by high concentration of NaCl, and gypsum is always the metastable phase under these conditions. Near surface formation of anhydrite by direct precipitation or alteration of gypsum probably occurs in nature by reaction of high sulfate continental waters with calcium carbonate or gypsum or by mixing of these waters with solutions containing calcium. — *from* Authors' abstract

Culberson, Charles. *See* Heath, G. Ross. 04886

05047 **Currie, Kenneth L.** Uniformity, uniformitarianism, and the foundations of science, [Chap.] 3 *in* Rock strata and the Bible record (P. A. Zimmerman, editor): St. Louis, Mo., and London, England, Concordia Publishing House, p. 40-51, 1970.

The basic unit of scientific reasoning is correlation, which assumes that a certain concatenation of observables has a unique physical significance. In order to discover information about processes producing correlations, it is necessary to reason from models; however, overpreoccupation with a model may deter scientific creativity. Bases for model construction in geology should be: observed analog, extrapolated analog, and scale-model experiments. Extrapolations in space and time can lead to erroneous conclusions. An historical sketch of geological thought indicates that in less than 200 years, geological science has progressed from nonsensory deductions to statistically based conclusions from observations. Although any geological conclusion is subject to alteration, this alteration will not affect observational evidence, nor correlations between evidence. Assumptions on which foundations of science rest are summarized. — MCM

05048 **Currie, Kenneth L.** Scientific methods of determining the age of the Earth, [Chap.] 5 *in* Rock strata and the Bible record (P. A. Zimmerman, editor): St. Louis, Mo., and London, England, Concordia Publishing House, p. 68-92, 1970.

Speculation on age of the Earth dates back almost as far as written records, but modern scientific ideas are generally considered to stem from Steno (1638-1687) and Hooke (1635-1703); a brief historical summary indicates pitfalls of the various methods used prior to the discovery of radioactivity. A brief account of dating methods with their requirements, difficulties, loopholes, and discrepancies is presented. Two of the three proposed methods of finding the age of the Earth date the formation of the Earth as an independent body, or perhaps some event in its very early life, while the third, which gives an idea of the age of the solar system, depends on astrophysical theory. Current estimate of the age of the Earth according to the various scales is 4.55 b.y. — MCM

05049 **Currie, Kenneth L.** Overview of the geological record, [Chap.] 7 *in* Rock strata and the Bible record (P. A. Zimmerman, editor): St. Louis, Mo., and London, England, Concordia Publishing House, p. 116-123, 1970.

"History" to be derived from rocks is gained chiefly from their fossil content, composition of particles, texture, and structure. The geologic record is the composite pic-

ture of the observed sequences of sedimentary rocks for a restricted span of time. To indicate that anomalies *can* be caused by certain processes is different than stating they *are* caused by this process. An apparent contradiction among data is generally found in a limited area, but can be quite spectacular, often leading to new concepts — i.e., the turbidity current concept. The number of unexplained anomalies has tended to grow with the growth in geological knowledge; the catastrophic concept deserves a serious reappraisal. — MCM

Curtin, Gary C. *See* Braddock, William A. 04507

04550 **Cushing, E. M.; Boswell, E. H.; Speer, P. R.; Hosman, R. L.** (and others). Availability of water in the Mississippi embayment: U.S. Geol. Survey Prof. Paper 448-A, p. A1-A13, illus., tables, 1970.

Most of the Mississippi embayment is underlain by aquifers that will yield large quantities of water to wells. Ground water with dissolved-solids content of less than 500 ppm is generally available at depths less than 1,000 feet; that of less than 1,000 ppm at depths more than 2,000 feet. Iron is the most common troublesome chemical constituent. Potential yield of aquifers is estimated to be about 30,000 mgd, of which about 3,000 mgd is presently being withdrawn. Water in varying amounts is also available from streams. — *from* Authors' abstract

04633 **Daily, Fay Kenoyer.** Fossil charophytes from South Dakota and Iowa with a review of modern species: Am. Midland Naturalist, v. 84, no. 2, p. 365-375, illus., table, 1970.

Several samples of glacial or postglacial sediments containing charophytes were provided by Fred V. Steece, South Dakota Geological Survey. Modern species represented are *Chara contraria*, *C. sejuncta*, and *C. delicatula*. Illustrations and a discussion of the nomenclature, taxonomy, and characteristics of modern *C. delicatula* help interpret the fossil material. Some lime shells of *Latochara waynei* provide new information about the species and the study verifies the wide geological range of the genus. A single specimen is referred to *Peckichara coronata*, known formerly from the Eocene. — Author's abstract

04493 **Damon, Norman; Wiggins, Jack L.** (editors). International oil and gas development, yearbook 1970 (review of 1969) — V. 40, Pt. 1, Exploration (annual review of geological and geophysical prospecting, land and leasing activities, wildcat exploration, and proven field development in United States and Canada): Austin, Tex., Internat. Oil Scouts Assoc., 486 p., illus., tables, 1970.

04528 **Darnley, A. G.; Grasty, R. L.; Charbonneau, B. W.** Highlights of GSC airborne gamma spectrometry in 1969: Canadian Mining Jour., v. 91, no. 4, p. 98-101, illus., tables, 1970.

Some of the more economically significant aspects of the Geological Survey of Canada's airborne spectrometry work are summarized. Experiments in the Bancroft and Uranium City areas have confirmed the importance of uranium to thorium and uranium to potassium ratios as indicators of localized uranium concentration. The greatest benefit of gamma-ray spectrometry compared with total radioactivity measurements is that with spectrometry, interpretation is no longer primarily related to magnitude of anomalies. The equipment was used in a mapping mode for a detailed survey in the Bancroft area, and in a line reconnaissance mode for a flight from Ottawa to Yellowknife. The geochemistry and mineralogy of radioactive deposits, considered briefly, aid appreciation of the advantages of high-sensitivty gamma-ray spectrometry. Profiles from the two flights are interpreted and show uranium deposits and igneous rocks by uranium-thorium ratios. — ESL

04532 **Davies, J. L.** Geology and exploration opportunities in northern New Brunswick: Canadian Mining Jour., v. 91, no. 4, p. 63-65, illus., 1970.

Five mineral zones can be outlined, each containing one or more different types of deposits. The Kedgewick, Matapedia-Aroostook, Tobique (North), and Miramichi

(North) zones are described. The last two have producing polymetallic deposits: in Tobique, along the Miramichi zone border; in Miramichi, in the underlying Tetagouche Group. In the latter, two main types of metallic mineral deposits occur, fine-grained imperfectly banded stratabound bodies, and veins of pyrite, sphalerite, and galena, containing silver. — ESL

Deere, D. U. *See* Nair, K. 05029

DeFelice, J. *See* Fireman, E. L. 04555

05042 **Deffeyes, Kenneth S.** The axial valley, a steady-state feature of the terrain, [Chap.] 9 *in* The megatectonics of continents and oceans (Helgi Johnson and Bennett L. Smith, editors): New Brunswick, N. J., Rutgers Univ. Press, p. 194-222, illus., table, 1970.

This paper summarizes constraints that seem to restrict the choice of models of the axial valley of the mid-ocean ridge and then suggests a model that does not violate the constraints. The model is based on the cross section of the Troodos Massif of Cyprus which has been interpreted (Gass, 1968; Moores and Vine, in press) as representing a typical oceanic crust including the M-discontinuity and an outcrop of the mantle. Assumptions are made that the Cyprus outcrops are a valid sample of sea floor and that a spreading rate of less than 3 cm/yr would produce the Cyprus pattern. — VSN

04480 **DeGeoffroy, J.; Wignall, T. K.** Statistical decision in regional exploration — Application of regression and Bayesian classification analysis in the southwest Wisconsin zinc area: Econ. Geology, v. 65, no. 7, p. 769-777, illus., tables, 1970.

A statistical decision model based on regression and Bayesian classification techniques is designed to help predict the most favorable drilling targets in regional exploration programs. The procedure is applied to a 225-sq-mi portion of the southwest Wisconsin zinc area hitherto little explored. The analysis led to selection of 22 targets with high success probabilities (0.80 or better) and high regression estimates. The validity of the method depends on the quality of field data and on a careful selection of relevant factors rather than the nature of the field techniques used for the coverage. The aim of the method is to assist the exploration management in making objective decisions fully consistent with the initial goals of the programs. — Authors' abstract

Dellwig, Louis F. *See* Rau, Jon L. 04466

Dellwig, Louis F. *See* Rau, Jon L. 04562

Delo, David M. *See* Reeves, Robert G. 04588

04754 **Denning, Ellis.** Bayou Pigeon Field, Iberia Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 2-2b, illus., 1970.

04622 **Derr, John S.** Discrimination of earthquakes and explosions by the Rayleigh-wave spectral ratio: Seismol. Soc. America Bull., v. 60, no. 5, p. 1653-1668, illus., tables, 1970.

Limited data from a long-period vertical seismometer and the prototype of a new mercury tiltmeter at the station, Harvard, Mass., tend to confirm that the Rayleigh-wave spectral ratio of short- to long-period energy provides a useful discriminant for underground explosions in the western United States at distances of from 28° to 38° in the range $M_s = 3.5$ to 5.6, corresponding to discrimination in the range $m_b = 5.0$ to 6.3. The same spectral ratio, however, does not discriminate the large Milrow event in the Aleutians from earthquakes in the same region. The Rayleigh spectral ratio complements the M_s-m_b discriminant by providing a clear separation of earthquakes and explosions in some geographical regions where earthquakes are of low stress drop and generally strike-slip in mechanism. — *from* Author's abstract

04904 **Desborough, George A.; Larson, Richard R.** Nickel-bearing iron sulfides in the Onaping Formation, Sudbury Basin, Ontario: Econ. Geology, v. 65, no. 6, p. 728-730, tables, 1970.

The Onaping Formation is the lowest member of the Whitewater Series in the central Sudbury Basin and is composed almost entirely of fragments of basalts and granites. Minor amounts of nickel-rich marcasite and pyrite associated with nickel-bearing pyrrhotite occur as disseminated grains and aggregates within or adjacent to these fragments. The nickel content is not of economic interest but does indicate that widespread low-grade nickel mineralization occurred several thousand feet above the magmatic rocks that contain large nickel sulfide ore bodies. Studies of polished surfaces, thin sections and of electron probe and X-ray fluorescence analyses are discussed. — VSN

04996 **Deshwar, K. H. S.** Determining in-situ rock strength: Eng. and Mining Jour., v. 171, no. 5, p. 84-85, illus., tables, 1970.

Comparison of results of rock strength determination computed by finite element analysis with field tests confirms its validity. In rock mechanics problems, behavior of in-situ rock with inherent geologic discontinuities, must be considered. A criterion for estimating the mass fracture coefficient was formulated and properties of in-situ rock evaluated. A suggested procedure is: (1) several constants should be obtained by testing core samples in the laboratory; (2) spacing between major discontinuities should be determined in the field; (3) triaxial tests of unbroken and broken rock samples should be carried out under assumed confining pressures; (4) the equation obtained in (2) should be used to evaluate strength values; (5) the cored borehole should be instrumented with a precise rock-displacement measuring device; and (6) elastic deformation observed in the borehole should be compared with theoretical results. — ESL

04796 **Detterman, Robert L.** Early Holocene warm interval in northern Alaska: Arctic, v. 23, no. 2, p. 130-132, illus., 1970.

New evidence for an early Holocene warm interval has been obtained in a radiocarbon date of 8,400 ± 300 yr B.P. obtained from a deeply buried poplar log near the Sagavanirktok River in the White Hills section of the Arctic coastal plain. This date, on wood near the type area of the Itkillik Glaciation confirms correlation with the well-documented early Holocene warm period in the Kotsebue Sound-Seward Peninsula area of northwestern Alaska, 500 mi to the southwest. Lack of signs of abrasion on the log suggests it was buried near the site where it grew; it was found about 6 m below the surface in terrace gravel, probably a glaciofluvial deposit formed during one of the younger advances of the Itkillik Glaciation, although it cannot be correlated with a specific glacial event. The date reported here is in good agreement with the established glacial chronology of northern Alaska. — GDC

04806 **Dibblee, T. W., Jr.; Hewett, D. F.** Geology of the Mojave Desert: California Div. Mines and Geology Mineral Inf. Service, v. 23, no. 9, p. 180-185, illus., 1970.

In the Mojave Desert low mountain ranges separate many undrained alluviated basins, which in central and eastern parts trend northwest and north. The types and distribution of Precambrian metamorphic rocks, Paleozoic strata and remnants engulfed in granitic intrusions, Mesozoic intrusions and metavolcanic masses, and distribution of metallic mineral deposits are reviewed. Thick Cenozoic sedimentary and volcanic units, unconformable upon pre-Cenozoic rocks which were deeply eroded in Cretaceous time, are briefly described. The Mojave Desert region is a wedge-shaped block, bounded on the southwest by the San Andreas fault and on the northwest by the Garlock fault, and broken by horizontal cross faults. In the eastern part, the old sedimentary rocks are compressed into north-trending folds, some broken by low thrust faults, themselves folded mostly before Mesozoic intrusions. — GDC

04906 **Dickinson, Kendell A.** The voyage of the Glomar Challenger on Leg X of the Deep Sea Drilling Project [abs.]: Corpus Christi Geol. Soc. Bull., v. 11, no. 2, p. 3, 1970.

04982 **Dickinson, William R.** Relations of andesitic volcanic chains and granitic batholith belts to the deep structures of orogenic arcs: Geol. Soc. London Proc. 1969, no. 1662, p. 27-30, discussion, 1970.

Cenozoic andesitic volcanic chains and Mesozoic granitic batholith belts are common in the circum-Pacific orogenic region. Heat flow above present arcs and trenches and inferred geothermal gradients during metamorphism in paired metamorphic belts suggest high T-P belts in subarc regions and parallel low T-P belts in subtrench regions. Correlation of potash content in lava suites of 75 active volcanoes with local depths to inclined seismic zones beneath holds equally well for basalts, andesites, and dacites. Occurrence of granitic rocks in composite batholiths suggests a magmatic origin, and some include a series of trends of granitic plutons of different age, which locally controlled anatexis cannot explain. Voluminous volcanogenic sequences of andesite contained in metamorphosed terranes in major batholith belts of western North America are in harmony with the idea that intruded eugeosynclinal prisms represent subsided andesitic arcs. — ESL

04999 **Dickinson, William R.** Geology for the masses: Jour. Geol. Education, v. 18, no. 5, p. 194-197, 1970.

The interdisciplinary aspect of teaching environmental geology at four levels of education is stressed. Beginning and general geology courses can easily be given an environmental approach. Undergraduate curricula should focus on solving problems involving geological hazards, natural resources and land use with the aid of related disciplines. Master's programs should include aspects of engineering, ground water, and mining geology. Doctoral research, to be considered environmental, must be thoroughly interdisciplinary. — EH

04657 **Dietz, Robert S.** Continental drift in space and time [abs.]: Houston Geol. Soc. Bull., v. 13, no. 2, p. 3, 1970.

04798 **Dietz, Robert S.** Continents and ocean basins, [Chap.] 3 *in* The megatectonics of continents and oceans (Helgi Johnson and Bennett L. Smith, editors): New Brunswick, N. J., Rutgers Univ. Press, p. 24-46, illus., table, 1970.

The ocean basins evolved from sea-floor spreading which developed when sufficient internal heat had been generated by decay of radioactive elements to establish thermal convection in the Earth. This in turn led to formation of continents and their growth by accretion. Before the Mid-Mesozoic breakup there were two supercontinents (Laurasia and Gondwana) separated by the universal ocean Panthalassa, of which the Pacific Ocean is a remnant. The Atlantic, Arctic, and Indian Oceans are mostly rift oceans. Wilson's (1966) concept that Laurasia and Gondwana collided in Mid-Paleozoic, and then rifted apart again in early Mesozoic essentially along the same geosuture is favored. This Paleozoic closing of the Atlantic implies Paleozoic drift and the existence of a trench within the primitive Atlantic toward which opposing cratons moved and collided. This trench then became the site of a spreading rift, a reversal implying a change in convection current patterns. — VSN

Dill, Charles E., Jr. *See* Swift, Donald J. P. 04724

04631 **Dillon, Lawrence S.** Speciation and changing environment, *in* Ecology and the origin of species — Am. Soc. Zoologists and Ecol. Soc. America, Symposium, Dallas, Tex., 1968: Am. Zoologist, v. 10, no. 1, p. 27-39, illus., 1970.

Current theories of geneticists regarding effects of environmental changes on speciation are reviewed briefly, and two speciation concepts of biogeographers, emphasizing climate as the selective force, are compared. Matthew's (1915) concept, based chiefly on paleontological evidence, agrees with the geneticists' concepts; it proposes that speciation is induced by changes in climate, and that the north temperate land masses are the centers of vertebrate evolution. Darlington's (1957) concept appears discordant with all the foregoing, but is in accord with observed modern distribution; it proposes that speciation is most rapid in tropical regions of vast extent, principally in the Old World. The two concepts are harmonized by showing that during the

period of most rapid evolution of vertebrates (Cretaceous-Eocene), the tropical belts included what are now the north temperate regions. — VMJ

04456 **Dimroth, Erich.** Evolution of the Labrador geosyncline: Geol. Soc. America Bull., v. 81, no. 9, p. 2717-2742, illus., tables, 1970.

The Labrador "trough," the 600-mi long preserved portion of an early Proterozoic geosyncline, is developed on a gneissic terrane in a continental setting. The trough was filled in two, or possibly three, tectonic cycles consisting of a quartzite-limestone sequence followed by shales. The filling terminated with flysch-like deposits in the western zone of the trough and with tholeiitic volcanics associated with peridotite sills in the central and eastern zones. The trough rocks were folded during the Hudsonian Orogeny, but the basement below the western part of the trough was not. — RGY

04766 **Dobie, C. Walter.** Jeanerette Field, St. Mary Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 14-14e, illus., 1970.

04945 **Doehring, Donald O.** Discrimination of pediments and alluvial fans from topographic maps: Geol. Soc. America Bull., v. 81, no. 10, p. 3109-3115, illus., tables, 1970.

Pediments and alluvial fans are commonly thought to differ in origin, yet it is difficult to distinguish between them without field evidence. Using working definitions, pediments and alluvial fans have been field-identified in the southwestern United States, and an algorithm employing data from high quality topographic maps has been developed to discriminate between the two landforms. The procedure is based on the observation that drainage texture tends to become significantly finer in a headward direction on pediments but not on alluvial fans. This relationship is of a statistical nature and analysis of variance or regression techniques can be employed for texture analysis and landform identification. — Author's abstract

04674 **Dolcater, D. L.; Syers, J. K.; Jackson, M. L.** Titanium as free oxide and substituted forms in kaolinites and other soil minerals [with French, German, and Russian abs.]: Clays and Clay Minerals, v. 18, no. 2, p. 71-79, illus., tables, 1970.

Titanium in TiO_2 minerals was differentiated from that isomorphously substituted into minerals by use of dihydrogen hexafluorotitanate, which selectively dissolved minerals containing substituted Ti^{4+}, leaving free crystalline TiO_2 minerals in the residue. Titanium analyses on the original samples and the residues, by wet chemical and neutron activation, indicated that an average of 86 percent of the titanium in seven kaolinite samples was present in the residual TiO_2 form, largely anatase, whereas only 28 percent in two bentonites was present in this form. Residual Ti accounted for 100 percent of the Ti in synthetic anatase and for 92 percent of the Ti in coarse clay-sized rutile, the latter suggesting that about 8 percent amorphous TiO_2 was removed from the mechanically dry ground rutile by the reagent. Ti present as residual TiO_2 in a variety of other samples ranged from 0 to 100 percent. — *from* Authors' abstract

04739 **Dolling, Raymond H.** Structural variation in river channel characteristics, Bronte Creek, Ontario [abs.]: Ontario Geography, no. 5, p. 84, 1970.

Dorman, James. *See* Barazangi, Muawia. 04624

Dort, Doris Stage. *See* Dort, Wakefield, Jr. 04570

04570 **Dort, Wakefield, Jr.; Dort, Doris Stage.** Low temperature origin of sodium sulfate deposits, particularly in Antarctica, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 181-203, illus., 1970.

Sodium sulfate is a common deposit in arid and semi-arid parts of the world; massive, almost pure accumulations of the decahydrate variety (mirabilite) occur in especially large quantities in western United States and Canada. Solubility of the hydrate increases with increasing temperature; that of the anhydrous form decreases. Although sodium sulfate minerals are not present in the suite commonly precipitated from evaporating seas, mirabilite is the first mineral, after ice, to crystallize from cooling sea water. In parts of the world other than Antarctica, mirabilite is precipitated in winter from saline lakes occupying closed basins where rainfall is deficient. The precipitate may redissolve in summer unless protected by subsequent deposition of clay or other impermeable material, in which case thick beds may build up. — *from* Authors' abstract

04685 **Douglas, Bruce M.; Ryall, Alan; Williams, Ray.** Spectral characteristics of central Nevada microearthquakes: Seismol. Soc. America Bull., v. 60, no. 5, p. 1547-1559, illus., tables, 1970.

Fourier amplitude spectra were computed for 40 central Nevada microearthquakes, selected to consider, independently, effects of azimuth and distance from known sources. Spectra were averaged for groups of events to eliminate peculiarities of individual records and emphasize group characteristics. Spectral characteristics did not behave systematically as a function of azimuth from the recording site to the source, but peak spectral frequency was found to correlate strongly with event magnitude and to some degree also with focal distance. These preliminary results suggest that recordings of small earthquakes and microearthquakes can be used to provide detailed information on the character of seismic signals related to properties of the source and propagation path. — Authors' abstract

Douglas, Richard F. *See* Robertson, David S. 04669

04733 **Dowling, John J.** Uncertainties in velocities determined by seismic refraction: Jour. Geophys. Research, v. 75, no. 32, p. 6690-6692, illus., table, 1970.

Uncertainties in the seismic-refraction-determined velocities of shallow layers propagate downward when dip is present. This increases the uncertainties in the velocities determined for the deeper layers. For a well-determined mantle velocity, this effect should not exceed 0.05 kmps. From this it can be shown that azimuthal variations in mantle velocity greater than 0.18 kmps indicate significant anisotropy. — Author's abstract

04682 **Duda, Seweryn J.** The earthquake volume: Seismol. Soc. America Bull., v. 60, no. 5, p. 1479-1489, illus., tables, 1970.

A method is presented enabling one to estimate the volume of seismic events with all possible magnitudes and focal depths. The underlying observational data are either the traveltimes of body waves, or the equivalent magnitude calibration curves for body waves, if the absorption of body waves is neglected. The method is applied to the newest P-wave traveltimes. The distance from the focus to a point at which a given critical strain existed during the event is computed. The volume within which strains larger than the critical prevailed during the event is obtained as a function of magnitude and focal depth. The volume so found is in agreement with a previous determination of the earthquake volume as a function of magnitude. — Author's abstract

Dugas, J. *See* Laurin, A. F. 04610

04667 **Duke, C. M.; Luco, J. E.; Carriveau, A. R.; Hradilek, P. J.; Lastrico, R.; Ostrom, D.** Strong earthquake motion and site conditions, Hollywood: Seismol. Soc. America Bull., v. 60, no. 4, p. 1271-1289, illus., tables, 1970.

On the basis of accelerograms recorded simultaneously in 1952 at the roof, in the basement and on the ground outside a 14-story building, Fourier spectrums were computed for the two horizontal components at each of the three recording places and were used after smoothing to compute the ratios of spectrums for adjacent

points. Dynamic models of the subsurface conditions, the foundation and the building were established. Certain of the spectral ratios were also determined theoretically. The primary result is the development of a method of isolating effects of site conditions in Fourier spectrums of accelerograms. Good theoretical checks were obtained on soil-structure interaction and structural response in the east-west direction. Plausible bedrock Fourier spectrums were also obtained. — DBV

04822 **Dunlap, John B., Jr.** Paleoecology as exploration tool [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1783, 1970.

04875 **Dunn, David L.** Conodont zonation near the Mississippian-Pennsylvanian boundary in western United States: Geol. Soc. America Bull., v. 81, no. 10, p. 2959-2974, illus., 1970.

Samples from 13 stratigraphic sections in Oklahoma, Texas, Utah, and Nevada were studied in conjunction with an investigation of conodonts in Late Mississippian (Chesterian) and Early Pennsylvanian (Morrowan) strata. Data pertaining to the placement of the Mississippian-Pennsylvanian and lower and upper Carboniferous boundaries are reviewed; it is concluded that the Mississippian-Pennsylvanian boundary, based on the occurrence of the conodont genus *Rhachistognathus*, occurs within the lower part of the western European *Homoceras* (H_1) Goniatite Zone. Several broadly occurring but seemingly thin conodont biostratigraphic zones believed to be useful for intercontinental correlations are established for Late Mississippian (Chesterian) and Early Pennsylvanian (Morrowan) rocks. — *from* Author's abstract

Dutta, N. K. *See* Mookherjee, Asoke. 04901

05107 **Dyal, P.; Parkin, C. W.; Sonett, C. P.** Lunar surface magnetometer experiment, *in* Apollo 12 preliminary science report: U.S. Natl. Aeronautics and Space Adm. Spec. Pub. SP-235, p. 55-73, illus., 1970.

Part one of the magnetometer experiment analysis covers field fluctuations longer than 10 days associated with remanent sources localized near the landing site or with the entire Moon; part two, with higher frequency periods between 10 days and 0.3 sec, involving transient induction of lunar fields by solar and Earth fields at different locations in the lunar orbit. Low-frequency data, averaged over the first 20-day period, indicate an average field magnitude of 36 ± 5 gammas and a field directed downward and toward the southeast. Higher frequency data tabulated here show typical field measurements during a 6-min period in each of three periods. Analyses indicate a magnetized portion of the Moon near the Apollo 12 site and a strong lunar inductive response to external magnetic fields. — JHF

04569 **Dyni, John R.; Hite, Robert J.; Raup, Omer B.** Lacustrine deposits of bromine-bearing halite, Green River Formation, northwestern Colorado, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 166-180, illus., tables, 1970.

Evaporite facies (bedded halite and nahcolite) in the Green River Formation, northwestern Colorado, are probably analogous to varves characterizing the formation's lacustrine marlstones. About 170 halite samples from one core hole near the evaporite depocenter contained bromine in amounts ranging from 15-182 ppm; the bromine in halite increased progressively from the base to near the top of the halite-bearing section. Contemporaneous volcanic sediments, or gaseous emanations, or older marine evaporites were suggested sources for the bromine. Paleosalinities of the ancient lake waters are interpreted to have gradually increased during rock deposition of the lower Parachute Creek Member containing the evaporites; paleosalinities decreased later during deposition of the Mahogany zone. — *from* Authors' abstract

04719 **Eaton, Theodore H.** The stem-tail problem and the ancestry of chordates: Jour. Paleontology, v. 44, no. 5, p. 969-979, illus., 1970.

Because of many striking similarities between early Paleozoic "carpoids" and primitive chordates, Jefferies (1967) removed the former from echinoderms and placed them in Chordata as a subphylum Calcichordata, assuming homology of the tail with the echinoderm stem. But this homology is not possible on embryological grounds, and in order for carpoids to be chordates, it is necessary that the tail be derived from a peduncle in a *Cephalodiscus*-like ancestor, while the echinoderm stem independently originated from the preoral lobe, likewise in some early hemichordate. Morphology of stolon, tail, or stem, feeding mechanisms, central nervous system, and embryology are compared for the related groups, and it is suggested that stemmed echinoderms (cystoids, etc.) and "carpoids" both originated from free pterobranchs and gave rise, respectively, to free echinoderms and to tunicates, amphioxus, and vertebrates. — *from* Author's abstract

Eberlein, G. D. *See* Churkin, M., Jr. 05004

04594 **Eckel, Edwin B.** The Alaska earthquake, March 27, 1964 — Lessons and conclusions: U.S. Geol. Survey Prof. Paper 546, 57 p., illus., 1970.

The greatest vertical and horizontal displacement of the land surface ever recorded for an earthquake resulted from displacement of a huge segment of the Earth's crust during the 1964 Alaskan earthquake. Local geologic conditions controlled most effects. Subaqueous slides, waves, and giant translatory slides did most damage. Comprehensive scientific investigations, using known and new techniques, produced new knowledge on use of tide-dependent barnacle lines and tilted lakes for measuring land-level changes, on worldwide hydroseisms in lakes and wells, and on stability of steep delta fronts and sensitive clays under dynamic conditions. Research is still needed on nature and prediction of earthquakes and on application of geology to planning or building in earthquake-prone areas. A selected bibliography and a comprehensive index to U.S. Geological Survey Professional Papers 541-546 close the volume. — EBE

04962 **Eckel, Edwin B.; Schaem, William E.** The work of the scientific and engineering task force, *in* The great Alaska earthquake of 1964 — Human ecology: Washington, D. C., Natl. Acad. Sci., p. 168-182, illus., 1970.

The Task Force was an arm of the Federal Reconstruction and Development Planning Commission for Alaska charged to gather engineering and earth-science information from all available sources, to interpret it, and to define those parts of the earthquake-damaged cities where reconstruction was inadvisable because of land-stability problems. A series of maps showing relative earthquake risk was prepared for Anchorage and Seward. The recommended activity for recovery of Homer [near entrance to Cook Inlet] was considered temporary, inasmuch as natural marine processes would eventually restore its usefulness as a harbor. — *from* Authors' abstract

Edgar, A. D. *See* Sood, M. K. 04986

Eggert, D. A. *See* Rothwell, G. W. 04665

Eggert, D. A. *See* Millay, M. A. 04668

04781 **Ehmann, W. D.; Gillum, D. E.; Morgan, J. W.; Nadkarni, R. A.; Rabagay, T. V.; Santoliquido, P. M.; Showalter, D. L.** Chemical analyses of the Murchison and Lost City meteorites: Meteoritics, v. 5, no. 3, p. 131-136, tables, 1970.

The abundances of 22 elements have been determined in the recently fallen Murchison and Lost City meteorites. Analyses were performed by 14-MeV neutron activation, thermal neutron activation, and in a few cases by wet chemical techniques. On the basis of these data the composition of the Murchison chondrite is intermediate between previously reported analyses of Type II and Type III carbonaceous chondrites. The data for the Lost City chondrite in general agree well with mean values reported for H-group ordinary chondrites. The low oxygen content of the Lost City chondrite suggests that previously reported oxygen abundances in H-

group falls may be too high due to oxidation in storage or weathering prior to collection. – Authors' abstract

04705 **Eicher, Don L.; Worstell, Paula.** Cenomanian and Turonian foraminifera from the Great Plains, United States: Micropaleontology, v. 16, no. 3, p. 269-324, illus., 1970.

The upper Cenomanian and lower and middle Turonian Greenhorn Formation and the Fairport Member of the Carlile Shale in the Great Plains region yielded 23 planktonic and 61 benthonic foraminiferal species. One benthonic genus, *Orithostella*, eight benthonic species, and one planktonic species, are new. Lack of benthonic specimens in the Lincoln and Hartland Members of the Greenhorn possibly resulted from lack of oxygen at the sea floor. Diverse benthonics in the basal Bridge Creek Member possibly resulted from increased circulation during the sea's maximum extent and depth. Paucity of benthonics in the upper Bridge Creek and Fairport suggests a partial return to restrictive conditions. — Authors' abstract

04671 **Elder, J. L.; Kube, W. R.** (compilers). Technology and use of lignite — A symposium, Bureau of Mines-University of North Dakota, Grand Forks, N. Dak., 1969, Proc: U.S. Bur. Mines Inf. Circ. 8471, 174 p., illus., tables, 1970.

Fifteen papers describe recent trends, developments, and research in lignite technology. Among the subjects included are an appraisal of lignites' place in the total energy concept, the effects of surface mining on environment, and operational experience and experiments on utilization of lignite for power generation and plant growth stimulation. — ERL

05003 **Elsdon, R.** The Kap Edvard Holm complex, east Greenland [abs.]: Geol. Soc. London Proc. 1970, no. 1663, p. 158-160, discussion, 1970.

04744 **Embley, R. W.; Ewing, J. I.; Ewing, M.** The Vidal deep-sea channel and its relationship to the Demerara and Barracuda Abyssal Plains: Deep-Sea Research, v. 17, no. 3, p. 539-552, illus., 1970.

A seismic profile from the Amazon Cone to the eastern end of Barracuda Fault trough reveals a series of three ponded turbidite levels; the deepest is Barracuda Abyssal Plain. The main source of turbidites is the Amazon region. A JOIDES hole in turbidites of Vema Fracture Zone has revealed very high sedimentation rates, but their relation to Demerara Abyssal Plain sediments is unclear. A major deep-sea channel (Vidal Channel) crosses the two levels of the northern Demerara Abyssal Plain and ends in eastern Barracuda Abyssal Plain; it is the principal access for turbidites to the latter. The main channel has a length of at least 800 km and an average gradient of 1:1100. Reflection records indicate an abrupt gradient change in the northern end due to differential erosion. Backcutting has been a major factor in channel formation. — *from* Authors' abstract

04987 **Emeleus, C. H.; Harry, W. T.** The Igaliko Nepheline Syenite Complex — General description: Medd. Grönland, v. 181, no. 3, 116 p., illus., table, geol. maps, 1970.

These Precambrian syenites in the Julianehaab District belong to the Gardar Igneous Province. Four distinct intrusive centers, in order of decreasing age, the Motsfeldt, North and South Qôroq, and Igdlerfigssalik Centres, with small satellite bodies and dike swarms, are described as to mineralogy, structure, and age relations. Igneous layering and mineral lamination define concentric and inward-dipping internal structures; frequency with which they are truncated by a later syenite indicates appreciable time between intrusions. Igneous activity in the Igaliko Complex began at least as early as mid-Gardar. Earliest syenites intrude the Eriksfjord Formation and cut a dolerite dike of an early(?) Gardar swarm. Mid-Gardar swarms maintain regional WSW-ESE strike except for a marked northerly swing near Qôroq. Two sinistral faults, ESE and E-W, displace the earlier Complex centers and the dikes; latest syenites are late-Gardar. — GDC

04639 **Empson, F. M.; Bradshaw, R. L.; McClain, W. C.; Houser, B. L.** Results of the operation of project Salt Vault, a demonstration of disposal of high level radioactive

solids in salt, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 455-462, illus., 1970.

Large amounts of very radioactive material were placed in holes in the Hutchinson salt near Lyons, Kansas, and then removed. Average radiation dose to the salt over the length of the holes was about 8×10^8 rads, and the peak dose was about 10^9 rads. The peak temperatures reached 200°C adjacent to the holes. The structural properties of the salt were not affected by the high doses and rates, but the extensive heating did produce effects not anticipated. These results included: (1) the migration of small intercrystalline brine inclusions along thermal gradients, and (2) the transfer of thermal stresses over seemingly extraordinary distances. — *from* Authors' abstract

04526 **Engels, J. C.; Ingamells, C. O.** Effect of sample inhomogeneity in K-Ar dating: Geochim. et Cosmochim. Acta, v. 34, no. 9, p. 1007-1017, illus., tables, 1970.

Error in K-Ar ages is often due more to deficiencies in the splitting process, whereby portions of the sample are taken for potassium and for argon determination, than to imprecision in the analytical methods. The effect of the grain size of a sample and of the composition of a contaminating mineral can be evaluated, and this provides a useful guide in attempts to minimize error. Rocks and minerals should be prepared for age determination with the effects of contaminants and grain size in mind. The magnitude of such effects can be much larger than intuitive estimates might indicate. — Authors' abstract

04518 **Engineering-Science, Inc.** Annotated bibliography on hydrology and sedimentation, 1966-1968, United States and Canada: Joint Hydrology-Sedimentation Bull. 10, 613 p., 1970.

05005 **England, C. B.; Stephenson, G. R.** Response units for evaluating the hydrologic performance of rangeland watersheds: Jour. Hydrology, v. 11, no. 1, p. 89-97, illus., tables, 1970.

A technique is presented for isolating areas within rangeland watersheds which are homogeneous enough in hydrologic characteristics to permit their use as field experimental units or as computational units in hydrograph synthesis. A study of the interactions among geology, soils, topography, and climate on the 90-square mile Reynolds Creek Experimental Watershed, Idaho, revealed predictable relations among these features and the capacity of a given unit of landscape to retain precipitation. The range site concept incorporates similar considerations and may be used in deriving hydrologic units for synthesizing the hydrology of ungaged areas. — Authors' abstract

04684 **Ericsson, Ulf A.** Event identification for test ban control: Seismol. Soc. America Bull., v. 60, no. 5, p. 1521-1546, illus., 1970.

This paper describes a method of determining the usefulness of seismological event identification criteria for underground test ban control with or without on-site inspection. The method is based on the idea that such control should be a deterrent, by confronting a prospective violator with a certain probability of disclosure at a politically determined level. The method applies simple decision theory to the statistical properties of identification measures and provides clean separation of the political requirements from the seismological capabilities. Application to some published observations shows identification by short-period body-wave magnitudes and long-period surface-wave magnitudes to be most efficient. It remains, however, to extend the analysis to weak events and low signal-to-noise analysis. The acquisition of suitable statistics is essential. — DBV

05079 **Ernst, W. G.; Seki, Yotaro; Onuki, H.; Gilbert, M. C.** Comparative study of low-grade metamorphism in the California Coast Ranges and the Outer Metamorphic Belt of Japan: Geol. Soc. America Mem. 124, 276 p., illus., tables, geol. maps, 1970.

Results are given of cooperative field and laboratory investigations of portions of Franciscan and Sanbagawa blueschist terranes. California Coast Ranges and Japan's

central Shikoku are contrasted as to: local areal relationships, petrology, and regional structures; metamorphic assemblages, phase compositions, and mineral paragenesis; nature of element partitioning among co-existing minerals; inferred physicochemical conditions during metamorphism; and relation of blueschist facies metamorphism to circum-Pacific orogenesis. Statistical analyses and measurements are tabulated in a supplement (Seki and others, 1969). Radiometric ages for Franciscan metamorphics are close to Mesozoic fossil ages of original clastic units, recrystallized soon after their eugeosynclinal deposition. Sanbagawan volcanogenic sediments are older, longer metamorphosed with varying intensity. Concluding tectonic implications involve rapid convergence of continental and oceanic crust. — GDC

04573 **Evans, Robert.** Genesis of sylvite- and carnallite-bearing rocks from Wallace, Nova Scotia, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 239-245, illus., 1970.

Analysis of a rock core from this area reveals that sylvite occurs with halite and minor carnallite in a matrix of dense clay/mudstone, or with halite in a halite/mudstone breccia. Petrographic examination reveals sylvite as a secondary product of the leaching of carnallite. Halite pseudomorphs after carnallite are abundant, and the replacement series halite after sylvite after carnallite is well-developed. Talc developed as a reaction product between $MgCl_2$-rich brines and the silicates of the clay matrix. Diapiric movement of the evaporites probably produced the brecciation, and elevated the potassium-bearing zones to their present position. The original potassium-bearing sediment was probably a carnallite- and halite-rich clay. — HRC

04578 **Evans, Robert; Linn, Kurt O.** Fold relationships within evaporites of the Cane Creek anticline, Utah, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 286-297, illus., 1970.

Locally, the shaly dolomite-anhydrite bed and the potash bed have been deformed into folds having wave lengths between 100 and 400 feet and an amplitude from 20 to over 100 feet. The anhydrite laminae in the sylvinite and salt beds below contain smaller folds related to the folds in the overlying dolomite-anhydrite. The minor folds have a uniform sense of symmetry, their limbs are attenuated and broken, and the intensity of the folding in the sylvinite and salt increases downward from the dolomite-anhydrite. The most severe minor folding occurs where the overlying dolomite-anhydrite itself is folded. A compressive stress early in basin history buckled the anhydrite laminae in the sylvinite and halite. These were later modified by passive flow, and ultimately the anhydrite-dolomite bed was folded, the cores deforming the deformable beds below. — *from* Authors' abstract

Ewing, J. I. *See* Embley, R. W. 04744

Ewing, M. *See* Embley, R. W. 04744

04787 **Facer, R. A.** Continental drift — Implications of paleomagnetic studies, meteorology, physical oceanography, and climatology (a discussion [of paper by A. A. Meyerhoff, 1970]): Jour. Geology, v. 78, no. 5, p. 630-633, 1970.

For paper by Meyerhoff, *see* ibid., v. 78, no. 1, p. 1-51, 1970; Abs. North American Geology, July 1970.

Fairbairn, H. W. *See* Spooner, C. M. 04626

04753 **Fambrough, James W.** Abbeville Field, Vermilion Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 1-1d, illus., 1970.

05061 **Feth, J. H.** Saline groundwater resources of the conterminous United States, *in* Saline water symposium: Water Resources Research, v. 6, no. 5, p. 1454-1457, 1970.

Saline water is arbitrarily defined as water containing more than 1000 milligrams per liter of dissolved solids. Saline ground water is known to underlie about two-thirds of the 48 states. Locally, aquifers yield saline ground water in profuse quantities, some of which is used by industry, particularly for cooling. Generally, however, saline water has been considered a nuisance. In this report it is dealt with as a resource, especially for the future. Forty chemical types of mineralized ground water were recognized, but sodium chloride dominates the occurrences and is almost the only type found where concentrations exceed about 20,000 mg/l. The occurrence and hydrologic properties of saline water aquifers deserve much more study than they have had. — Author's abstract

04670 **Ficklin, Walter H.** A rapid method for the determination of fluoride in rocks and soils, using an ion-selective electrode, *in* Geological Survey research 1970, Chap. C.: U.S. Geol. Survey Prof. Paper 700-C, p. C186-C188, tables, 1970.

A rapid method for the direct determination of fluoride in rocks and soils is presented. No prior separation of fluoride by distillation is required. Results are listed for 19 rock samples from the Cripple Creek mining district of Colorado, 8 U.S. Geological Survey standard rock samples, and 5 soil samples from New Mexico. The results determined by the proposed method agree to within about 20 percent of the values obtained by other methods and are reproducible to within about 15 percent. The minimum fluoride content detected is 40 ppm. — Author's abstract

04555 **Fireman, E. L.; DeFelice, J.; Norton, Elinor.** Ages of the Allende meteorite: Geochim. et Cosmochim. Acta, v. 34, no. 8, p. 873-881, tables, 1970.

Measurements of the rare gases, K, and U in whole-rock and chondrule samples of Allende showed enrichment in He-4, Ar-40, K, and U, and depletion of the primordial gas in the chondrules. The U, Th-He age of the chondrules is 4.2 ± 0.2 b.y., and the K/Ar-40 age is 4.44 ± 0.14 b. y. With correction for primordial He-4, the U, Th-He whole-rock age is 3.4 ± 0.2 b.y.; the K-Ar whole-rock age is 4.55 b.y. The chondrules are enriched in excess Xe-129 and depleted in primordial Xe. The Xe-129/Xe-132 ratios and the Xe-129 excess in the chondrules are exceptionally high. Two troilite-bearing chondrules have a Xe-129/Xe-132 ratio of 92, the highest ever observed, and a very large Xe-129 excess. The I contents of the chondrules range from 59 to 135 ppb; $(Xe\text{-}129/I_{max})$ from 0.42 to 1.39×10^{-4}. — DBV

04481 **Fischer, R. P.** Similarities, differences, and some genetic problems of the Wyoming and Colorado Plateau types of uranium deposits in sandstone: Econ. Geology, v. 65, no. 7, p. 778-784, table, 1970.

Although both Wyoming roll type and Colorado Plateau peneconcordant type uranium deposits have many similarities and are thought to have formed by reduction precipitation from ground waters before deformation, they differ in several respects. Wyoming deposits are in unlithified, highly arkosic sandstone, whereas Colorado deposits are in lithified, slightly arkosic sandstone. Uranium is the only ore metal in Wyoming, whereas vanadium or copper is more abundant than uranium in some Colorado deposits. Wyoming deposits are elongate crescent-shaped bodies that extend vertically through a sandstone unit, whereas Plateau deposits are thin tabular layers nearly concordant to bedding. Wyoming ore rolls and interfaces are dynamic, whereas Plateau deposits seemingly formed as static bodies. Differences suggest genetic problems relating to Eh of ore-bearing and altering solutions, shape and localization of deposits, and source of uranium. — VSN

04823 **Fisher, William L.; Proctor, Cleo V., Jr.** Depositional systems in Jackson Group of Texas Gulf Coast basin [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1783-1784, 1970.

05028 **Fleck, R. J.** Age and tectonic significance of volcanic rocks, Death Valley area, California: Geol. Soc. America Bull., v. 81, no. 9, p. 2807-2815, illus., tables, 1970.

K-Ar dating of the Artist Drive Formation or "Older Volcanics" in the Death Valley region, yields ages between 6 and 9 m.y. Determinations on both older and younger

units substantiate these values and compress the tentative chronology of the region outlined by previous authors. Two temporally and structurally distinct episodes of deformation are postulated, which may be responsible for the diverse structural features referred to the Amargosa chaos or thrust complex. Tectonic implications include the synchroneity of normal faulting, strike-slip faulting, folding, and formation of at least part of the Amargosa chaos in the last 6 m.y. — *from* Author's abstract

04533 **Fleming, J. M.** Developments and opportunities in Newfoundland and Labrador: Canadian Mining Jour., v. 91, no. 4, p. 57-60, illus., 1970.

Analysis of mineral development in the past decade is presented; the value of mineral production increased by more than 230 percent. Iron deposits of the Labrador Trough account for 80 percent of the production. Occurrences of the following commodities are described: base metals, tungsten, uranium, molybdenum, and fluorspar. Newfoundland and Labrador are relatively unexplored, but mapping programs are being carried out by the Geological Survey of Canada. — ESL

04949 **Fletcher, K.** Some applications of background correction to trace metal analysis of geochemical samples by atomic-absorption spectrophotometry: Econ. Geology, v. 65, no. 5, p. 588-589, tables, 1970.

To evaluate significance of background absorption, USGS standard rock samples AGV-1, BCR-1, G-2, GSP and W-1 were analyzed for cobalt, copper, lead, nickel, and zinc. Samples and calibration standards were digested in hydrochloric and other acids and both were aspirated into the air-acetylene flame and absorbance measured with a spectrophotometer. Background absorption was measured by replacing the hollow-cathode lamps with a hydrogen lamp giving a spectral continuum between 2,000-4,000 A. Solutions were re-aspirated, and absorbance was measured at 10 A band pass region of each analytical line. Results are tabulated, and clearly indicate presence of background absorption when rock digests are aspirated into the air-acetylene flame; interferences are severe for Co, Pb, and Ni. By measuring absorption of a spectral continuum in the region of the atomic-absorption line, a suitable correction can be applied. — VSN

Flory, D. *See* Oró, J. 05088

04824 **Forgotson, James M., Jr.** Well-data files and computer, exploration tools for the seventies [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1784, 1970.

04897 **Fowler, Gerald A.; Kulm, L. D.** Foraminiferal and sedimentological evidence for uplift of the deep-sea floor, Gorda Rise, northeastern Pacific: Jour. Marine Research, v. 28, no. 3, p. 321-329, illus., tables, 1970.

Displaced benthic Foraminifera in semiconsolidated clayey sandstone from the Gorda Rise provide evidence for uplift of the deep-sea floor. The sediment was deposited by turbidity currents on the floor of the Escanaba Trough (the axial valley of the Gorda Rise) from a sublittoral source on the continental margin to the east. Subsequent tectonism has lifted the sediment 1000 m up the flanks of the axial valley in approximately the last million years. For the coarse fraction, heavy-mineral data indicate a Klamath Mountain provenance; for the fine fraction, clay mineralogy indicates a probable derivation from the lower Columbia River and the Snake River sub-basins and from the Klamath Mountains. — Authors' abstract

Fowler, W. A., Jr. *See* Tipsword, H. L. 04843

04597 **Frank, F. J.** Ground-water resources of the Clatsop Plains sand-dune area, Clatsop County, Oregon: U.S. Geol. Survey Water-Supply Paper 1899-A, p. A1-A41, illus., tables, 1970.

The Clatsop Plains area is underlain by Tertiary bedrock of low permeability that stores and yields small quantities of ground water which may be of poor quality, and that furnishes only minor ground-water discharge to maintain base flow of streams. The lowlands are overlain by extensive deposits of dune and beach sand; the permea-

ble dune sand can absorb and store a large percentage of annual precipitation; most ground water in the sand discharges to the ocean but some could be recovered by pumping from wells. It is estimated that 2,500 acre-feet of ground water per yr per sq mi of area may be available for withdrawal in the 10-sq-mi area most favorable for development. Water from dune sand is soft to moderately hard, has low chloride concentration, and is of generally good quality, except in places where iron concentration is excessive. — *from* Author's abstract

Franzgrote, Ernest J. *See* Patterson, James H. 05094

04775 **Frazell, W. D.** North Elton Field, Allen Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 22-22d, illus., 1970.

04551 **Frick, G.** Wasserschliessung in Haiti [Water resources development in Haiti]: Wasser u. Boden, v. 22, no. 8, p. 226-228, illus., 1970.

A brief description of the geology of Haiti precedes a report on wells drilled recently with the assistance of the Federal Republic of Germany. — EH

04726 **Friedman, Gerald M.; Sanders, John E.** Integrated continental-shelf and marginal marine environmental research program — Sediments, organisms and waters in New York Bight and vicinity: Maritime Sediments, v. 6, no. 1, p. 26-29, illus., 1970.

As part of an integrated program to study environmental relationships among bottom sediments, microorganisms, and waters (surface, bottom, and interstitial) in New York Bight, this study was extended to include the coastal environment in Great South Bay, Long Island, and near the mouth of the Connecticut River. Data obtained from hydrochemical studies, analyses of sediment particles, X-ray radiography of sediment cores, and para-ecological studies of benthonic foraminifera and associated microorganisms are included. — EH

05012 **Friedman, Gerald M.** The Bahamas and southern Florida — A model for carbonate deposition: Shale Shaker, v. 21, no. 1, p. 4-12, 14-15, illus.; discussion, p. 17-20, 1970.

Most major oil companies, drilling deeper wells at greater expense, send their exploration geologists to the Bahamas and Florida to learn recognition of carbonate environments in the processs of deposition; and prediction of favorable interfingering facies, where their sharp boundaries are startling. An understanding of the sequence of facies changes and marine processes responsible for them is a necessary prerequisite to intelligent interpretation of wells drilled in carbonate terranes. The Oklahoma Geological Society is one of the first to organize a society-sponsored field trip to these areas, as an educational experience. Described are Pleistocene outcrops and modern carbonate sediments examined at trip stops and seen from the air, and in them and living in the water, various organic sources of hydrocarbons. — GDC

04866 **Fullagar, Paul D.; Bottino, Michael L.** Sulfide mineralization and rubidium-strontium geochronology at Ore Knob, North Carolina, and Ducktown, Tennessee: Econ. Geology, v. 65, no. 5, p. 541-550, illus., tables, 1970.

The upper Precambrian Ashe Formation wallrock of the Ore Knob, N.C., copper sulfide deposit has an apparent Rb-Sr whole-rock age of approximately 400 m.y.; Ashe Formation samples collected 5 to 35 miles from Ore Knob do not define an isochron, but results suggest an age between 550-950 m.y. Upper Precambrian Great Smoky Group samples from the ore zone, wallrock and country rock of the Cherokee mine, Ducktown, Tenn., give apparent Rb-Sr ages no older than 500 m.y.; samples with youngest apparent ages are in or close to the ore zone. Rubidium and strontium analyses indicate that Sr has been removed from and, at Ore Knob, Rb added to at least hundreds of feet of wallrock. This alteration, which lowered the radiometric age of the wallrock, probably occurred during although not necessarily at time of main ore mineralization; the 400 m.y. isochrons for the Ore Knob wallrock probably indicate the time of Ore Knob Rb-Sr alteration. — *from* Authors' abstract

04925 **Furumoto, A. S.; Campbell, J. F.; Hussong, D. M.** Seismic studies of subsurface structure in the Ewa Coastal Plain, Oahu, Hawaii: Pacific Sci., v. 24, no. 4, p. 529-542, illus., tables, 1970.

Seismic studies of the Ewa Coastal Plain, Oahu, Hawaii included well logging, refraction, and reflection methods in conjunction with core drilling. Well logging gave a complicated velocity-depth profile, with higher velocities in reef limestone and lower velocities in mud. Seismic refraction produced a simpler velocity-depth profile with a few distinct layers, and seismic reflection corroborated this. An averaging-out process can be applied to the whole sedimentary column so that a P-wave velocity value may represent the sedimentary layer at any given locality; however, no single value can be assigned as typical for sedimentary layers for the entire Hawaiian area as velocity values depend on composition of the layer with its varying proportions of mud, reef limestone, and weathered basalt. Layer 2 of the oceanic crust in Hawaii has velocities from 4.8 to 5.1 kmps, and thicknesses from 4 to 8 km. — VSN

04777 **Fuselier, George R.** Ridge Field, Lafayette Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 25-25c, illus., 1970.

Fyles, James T. *See* Society of Economic Geologists. 04909

04912 **Fyles, James T.** Geologic setting of the lead-zinc deposits in the Kootenay Lake and Salmo areas of British Columbia, [Chap.] 4 *in* Lead-zinc deposits in the Kootenay Arc, northeastern Washington and adjacent British Columbia — Soc. Econ. Geologists, 1970 Northwest Field Conf. Guidebook: Washington Div. Mines and Geology Bull. 61, p. 41-53, illus., table, 1970.

The largest and most numerous lead-zinc deposits in the Province are in the southeastern corner; three types are recognized: Salmo, Metaline, and Bluebell. This paper describes the geologic setting of the Salmo and Bluebell deposits, and outlines some characteristics of each type; the strata are Cambrian to late Mesozoic in age. Paleozoic nomenclature in the Kootenay arc is tabulated. Structure is dominated by complex multiple folds, with two phases, complicated by faults and intrusions. Rocks range from low to high grade regional metamorphism, with zones truncated by plutons. Salient features of selected deposits are summarized. The Salmo and Duncan deposits are disseminations of sulfides in calcareous host rock, controlled by Phase II structures. Some mineralization is controlled by zones of brecciated dolomite. Bluebell ore bodies are massive replacements of limestone controlled by cross-fractures, and are relatively young. — ESL

05023 **Gage, Maxwell.** The tempo of geomorphic change: Jour. Geology, v. 78, no. 5, p. 619-625, 1970.

Application of uniformitarian principles to geomorphic studies must be made with a proper sense of time required for geomorphic changes, and a realization that cumulative changes of small order probably are more important in the long run than short-term catastrophic changes, either large or small, that are not part of a continuing trend. Short-term studies therefore can lead to false inferences unless they are used with a proper sense of time perspective. — ETR

Gair, J. E. *See* Cannon, W. F. 04464

04692 **Gair, J. E.; Simmons, G. C.** Metadiabase sills in Negaunee Iron-Formation south of Negaunee, Michigan, *in* Changes in stratigraphic nomenclature by the U.S. Geological Survey, 1969: U.S. Geol. Survey Bull. 1324-A, p. A24-A30, illus., 1970.

04780 **Gallaspy, I. L.** West Lake Verret Field, St. Martin Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 30-30d, illus., 1970.

05021 **Galloway, R. W.** Coastal and shelf geomorphology and late Cenozoic sea levels: Jour. Geology, v. 78, no. 5, p. 603-610, illus., 1970.

Drowned valleys, cliffs, and erosional features of continental shelves require a prolonged period (or periods) of low sea level followed by a period of gradually rising sea level. Because tectonism cannot account for the relatively uniform depth of these features, and because Pleistocene glacioeustatic regressions were too brief, a hypothesis of preglacial low sea level caused by tectonic changes in ocean floors is proposed. Pleistocene glaciations temporarily restored sea level to near its preglacial position. Preglacial and interglacial high sea levels were relatively minor incidents in the late Cenozoic evolution of coasts. — Author's abstract

04664 **Galloway, Robert W.** The full-glacial climate in the southwestern United States: Assoc. Am. Geographers Annals, v. 60, no. 2, p. 245-256, illus., tables, 1970.

Colluvial mantles on the mountains of southwestern United States are believed to have formed during colder climates associated with the last glaciation. They imply mean temperatures 10-11° C lower than those of today and a depression of the timber line by 1,300-1,400 meters. Evaporation rates were about half the present values and by estimating runoff it is possible to reconstruct the full-glacial hydrologic budget of Pleistocene closed lakes. Precipitation was eighty to ninety percent of present values and there was no glacial pluvial. Pollen data can be reconciled with the proposed cold dry climate which has modern homoclimes at higher altitudes and latitudes. — Author's abstract

04808 **García-Bengochea, José I.; Vernon, Robert O.** Deep well disposal of waste waters in saline aquifers of south Florida, *in* Saline water symposium: Water Resources Research, v. 6, no. 5, p. 1454-1470, illus., table, 1970.

Florida is underlain by very rich water-bearing strata commonly referred to as the Floridan aquifer. Solution channels and caverns in carbonaceous rocks are found at different depth intervals in extensive, thick (several thousand feet) sections of limestones and dolomites. In south Florida the bottom part of the Floridan aquifer includes extremely cavernous strata commonly referred to as the 'Boulder Zone.' Chloride concentration in the water of the Boulder Zone is over 2000 mg/l. Because of this, large volumes of brine from oil fields are reinjected into this zone. Since 1966 industrial waste (essentially 1 percent acetic acid) has been injected into a disposal well drilled to the top of the Boulder Zone southeast of Lake Okeechobee. Planning and monitoring of this well have included the cooperation of government and private interests. Experiences, results, and potential of this zone for further similar uses are discussed. — Authors' abstract

Gard, L. M., Jr. *See* Carr, W. J. 04690

Garlick, G. F. *See* Brenden, B. B. 04782

04648 **Garrett, Donald E.** The chemistry and origin of potash deposits, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 211-222, illus., 1970.

A new theory assumes the solar evaporation of water in closed marine basins which have undergone extensive limnological stratification. The normally crystallizing potash salts schoenite, leonite, and kainite were converted to carnallite in passing through or residing in, the stronger lower brines; the carnallite was in turn converted to sylvite in the final flooding of the basin for that potash stage. Epsomite was removed from the brine by being crystallized in the cooler evenings or winters in the shallower zones, and finally was redissolved and flushed from the deposit at the same time as magnesium chloride from the carnallite. Since halite crystallizes continuously, it would have occurred with the carnallite, forming sylvinite in the final mixture. — *from* Author's abstract

Garrett, R. G. *See* Nichol, Ian. 04870

05097 **Gault, Donald E.** Saturation and equilibrium conditions for impact cratering on the lunar surface — Criteria and implications, *in* Symposium on planetary atmospheres and surfaces, Woods Hole, Mass., 1969: Radio Sci., v. 5, no. 2, p. 273-291, illus., 1970.

A model based on first principles and laboratory results is presented for describing and evaluating long term effects of meteoritic impact against the lunar surface. The evolution of the cratered surface and concomitant regolith is calculated and compared with observations and analyses of Lunar Orbiter photographs. It is indicated that most craters are of impact origin, but gross differences in the apparent ages of surfaces in various units and regions of the Moon imply that endogenic processes also must have been active, probably since the beginning of Precambrian time and, perhaps, as recently as a few million years ago. — Author's abstract

Gawarecki, Stephen J. *See* Braddock, William A. 04507

05013 **Gay, N. C.** The formation of step structures on slickensided shear surfaces: Jour. Geology, v. 78, no. 5, p. 523-532, illus., 1970.

The majority of the accretion steps observed on slickensided surfaces in experimentally deformed rocks were incongruous; that is, these steps had their risers opposing the movement of the overriding block. It is suggested that the steps are bounded by two sets of tension cracks, one parallel to the maximum compressive stress and the other perpendicular to the shear plane. On parting along the shear plane, these steps are plucked out and adhere to the opposite side of the shear plane. After a large amount of shearing, the shape of the steps may be modified so that they have a congruous attitude. — JCR

04981 **Gebhart, Ernest J.** Public lands in Ohio: Interstate Oil Compact Comm. Comm. Bull., v. 12, no. 1, p. 26-29, 1970.

Public lands in Ohio, quite limited, represent only a small percentage of the state's total area. Under state and federal management, mineral exploration or extraction is often precluded except for existing programs. Mineral interests under Lake Erie consist of sand and gravel, oil and gas, and salt, of which a few production figures are given; that part managed by the State of Ohio totals 2,257,549 acres. The Lake Erie drilling controversy, closely related to environmental quality considerations, is subject to continuing debate and further legal action. The primary mineral wealth of the State is in private ownership, contributing significantly to the state's economy. Future acquisition of land by both state and federal agencies is expected to be minimal and for specific public needs; opportunities for acquiring mineral rights will be minimal except on lands to be added to Wayne National Forest, subject to federal regulations. — GDC

04611 **Gees, Rudolph A.; Medioli, Franco.** A continuous seismic survey of the Bermuda Platform — Pt. 1, Castle Harbour: Maritime Sediments, v. 6, no. 1, p. 21-25, illus., table, 1970.

A continuous seismic survey was made in Castle Harbor to delineate the interface of the volcanics and capping sediments on the Bermuda seamount. Sixteen traverses revealed a bowl-shaped, caldera-like volcanic base, at depths ranging from about 100 feet at the edges to 300 feet at the center, overlain by a sequence of calcareous sedimentary material, varying in thickness from several tens of feet near the shoreline to > 200 feet near the center of the harbor. A reflector in the sediments may represent a peneplane of post-Walsingham age (>300,000 yr B.P.). Patch reefs, still actively growing, lie directly on eroded parts of the peneplane. — EH

04602 **Gelpi, E.; Han, J.; Nooner, D. W.; Oró, J.** Organic compounds in meteorites—[Pt.] 3, Distribution and identification of aliphatic hydrocarbons produced by open flow Fischer-Tropsch processes: Geochim. et Cosmochim. Acta, v. 34, no. 9, p. 965-979, illus., tables, 1970.

The possible abiotic synthesis of the aliphatic hydrocarbons in extraterrestrial samples was investigated, using as a model, the Fischer-Tropsch reaction between hydrogen and carbon monoxide. Iron of meteoritic origin, as well as commercial nickel and nickel-iron alloys, were used as the catalyst. This type of synthesis produced small amounts of saturated and unsaturated hydrocarbons ranging from C_3 to about C_{26}. The saturated hydrocarbons were found to be predominantly n-paraffins plus smaller amounts of methyl branched isomers (7-, 6-, 5-, 4-, 3-, 2-methyl al-

kanes). The individual concentrations of these synthetic hydrocarbons decrease continuously with molecular weight. Although n-alkanes and their monomethyl branched isomers have been detected by gas chromatographic-mass spectrometric techniques among the products of more than 60 experiments, no traces of isoprenoid hydrocarbons were found. — Authors' abstract

04603 **Gelpi, E.; Oró, J.** Organic compounds in meteorites—[Pt.] 4, Gas chromatographic-mass spectrometric studies on the isoprenoids and other isomeric alkanes in carbonaceous chondrites: Geochim. et Cosmochim. Acta, v. 34, no. 9, p. 981-994, illus., tables, 1970.

Nine homologous series of isomeric alkanes, in addition to the normal alkane series, have been identified by gas chromatographic and mass spectrometric techniques in hydrocarbon fractions from extracts of six carbonaceous chondrites. Two of these series show isoprenoid structures corresponding to 2,6,10-trimethyl and 2,6,10,14-tetramethyl alkanes ranging from C_{14} to C_{19} and C_{19} to C_{21}, respectively. The rest is made up five series of monomethyl alkanes (2-, 3-, 4-, 5-, 6-methyl alkanes) and two of monocycloalkanes (cyclohexyl and cyclopentyl). The presence of members of the n-paraffin series between C_{11} and C_{26} inclusive was also confirmed by mass spectral data. The hydrocarbon content ranged from 6.7 to 82.8 ppm. Isoprenoids are present in all samples analyzed. Usually they show a major maximum at C_{19} (pristane) and a secondary maximum at C_{18} (methyl farnesane) with a minimum at C_{17}. — *from* Authors' abstract

04604 **Gelpi, E.; Oró, J.** Organic compounds in meteorites—[Pt.] 5, Gas chromatographic-mass spectrometric studies on the isoprenoids and other isomeric alkanes in graphitic nodules of iron meteorites: Geochim. et Cosmochim. Acta, v. 34, no. 9, p. 995-1005, illus., tables, 1970.

Specimens of graphite-troilite nodules from 3 iron meteorites were studied following the same general techniques used on carbonaceous chondrites (Part 3 of this series; ibid., p. 965-979). The results in all cases are very similar to those obtained on the carbonaceous chondrites, although the amount of alkanes in the nodules is much lower (0.32-9.36 ppm). These hydrocarbons show only a slight odd over even predominance except in Cosby's Creek. Nine homologous series have been identified mass spectrometrically. Invariably the inner parts of the nodules had 3 to 7 times less alkanes than their surfaces, and relative content of low molecular weight alkanes was higher inside the nodules. The amount of isoprenoids relative to the n-alkanes was also significantly higher in the inner portions. The presence and distribution of these types of compounds in the graphitic nodules cannot be readily explained except on the basis of a contribution of extraneous terrestrial material. — DBV

04791 **Geological Society of America; Am. Geological Institute.** Bibliography and index of geology — Cumulative bibliography 1969: Boulder, Colo., Geol. Soc. America, 4 vols., 3654 p., 1970.

05015 **Ghose, Benoy K.** Regression analysis in paleobiometrics — A reappraisal: Jour. Geology, v. 78, no. 5, p. 545-557, tables, 1970.

In paleobiometrical studies regression analysis is a useful tool, but sometimes choosing an expression for this poses a problem. It is necessary to find whether the curve fitted to a set of data is a growth curve or not. In many cases it will be found that it is a mass curve and differs from the actual mean growth curve considerably. So an a priori choice of an expression (allometric or logistic) is not justified. Allometric equations should be used only when it can be shown by statistical tests that the regression is nonlinear. Sometimes sigmoids will be found to be more suitable to represent relative growth. To find interdependence between two characters, the reduced major axis method, or the "two group" or the "three group" method, may be used. — *from* Author's abstract

04487 **Ghosh-Dastidar, P.; Pajari, G. E., Jr.; Trembath, L. T.** Factors affecting the trace element partition coefficients between coexisting sulfides: Econ. Geology, v. 65, no. 7, p. 815-837, illus., tables, 1970.

Patterns of a few trace-element partition coefficients between coexisting minerals from six sulfide occurrences show that distribution patterns range from linear through curvilinear to scattered. Even in linear distributions, complexities exist. Some elements partition between a specific mineral pair from one deposit in accord with the dilute distribution law; others do not. In a majority of scattered and curvilinear patterns, the partition coefficient was dependent on element concentrations in either of the phases (concentration plots) and/or presence of other trace elements in the phases (interaction plots), indicating nonadherence to Henry's law. Similar patterns in plots from different assemblages suggest that patterns are independent of detailed paragenetic factors of deposits. Nonlinear distribution patterns do not necessarily mean minerals are in 'gross disequilibrium;' criteria are proposed to determine state of degree of equilibrium. — VSN

04764 **Gibson, G. G.** Grand Coulee Field, Acadia Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 12-12c, illus., 1970.

Gil-Av, E. *See* Oró, J. 05088

Gilbert, J. *See* Oró, J. 05088

Gilbert, M. C. *See* Ernst, W. G. 05079

05039 **Gilluly, James.** Crustal deformation in the western United States, [Chap.] 4 *in* The megatectonics of continents and oceans (Helgi Johnson and Bennett L. Smith, editors): New Brunswick, N. J., Rutgers Univ. Press, p. 47-73, illus., 1970.

Studies of gravity and seismic data in the western United States have revealed great variations in crust and mantle properties, and suggest that deformations of any crustal segment must depend on immediately underlying mantle and not on a world-wide stress system. The crust is too inhomogeneous and weak to transmit stress uniformly over wide regions. Thickness and elasticity of the oceanic crust is far more uniform than those of the continental crust, and the fracture zones in the oceanic crust are strong evidence for uniform stress patterns over great regions. The properties of the two crusts are so different that there must be nearly complete coupling of the two. Structures of the western United States are not incompatible with drift or rotation on a continental scale, but intracontinental rotation on known shear zones is trivial on a regional scale. — VSN

Gillum, D. E. *See* Ehmann, W. D. 04781

04653 **Glanville, C. R.** Log interpretations of gas sands from multiple-porosity and resistivity logging programs: Log Analyst, v. 11, no. 4, p. 3-11, illus., table, 1970.

A recommended logging program for finding and evaluating Miocene gas sands in Gulf Coast fields includes induction-electrical, density (with gamma-ray curve), and neutron logs. Interpretation procedures are: (1) use density and neutron logs to get porosity from clean sands and density log to get porosities from shaly sands; (2) use this information, combined with induction log resistivity (or conductivity) to detect pay sands and to estimate water saturations; and (3) use the combined information from all three logs to identify gas sands. This logging program and interpretation procedure for gas sands provides as much information of value as methods which entail the added cost of a sonic log and more complex calculations requiring a high-speed computer. —*from* Author's conclusions

04710 **Glawe, L. N.** *Chlamys menthifontis*, a new pectinid from the Oligocene of Mississippi: Jour. Paleontology, v. 44, no. 5, p. 858-866, illus., table, 1970.

A new pectinid bivalve species, *Chlamys menthifontis*, is qualitatively and quantitatively described from a study of 188 specimens collected from four localities in central Mississippi. *C. menthifontis*, known only from the Middle Oligocene Mint Spring Marl, is similar in external ornamentation to *C. deshayesii* (Lea) that occurs in the Middle and Upper Eocene formations of southeastern United States, and is considered to be derived from the *Chlamys deshayesii* stock. — *from Author's abstract*

Godfrey, Andrew E. *See* Cleaves, Emery T. 04877

04544 **Göke, Gerhard.** Eine kambrische Trilobitenfauna im Millard Co., Utah, USA [Some Cambrian trilobite fauna from Millard County, Utah, U.S.A.]: Aufschluss, v. 21, no. 7-8, p. 273-275, illus., 1970.

The author describes the following Middle- to Upper Cambrian trilobites found in the House Range, in Millard County, Utah: *Bolaspidella housensis, Elrathina cordillerae, Modocia typicalis, Cedaria minor*, and *Peronopsis interstrictus*. — EH

05111 **Gold, T.; Pearce, F.; Jones, R.** Lunar surface closeup stereoscopic photography, *in* Apollo 12 preliminary science report: U.S. Natl. Aeronautics and Space Adm. Spec. Pub. SP-235, p. 183-188, illus., 1970.

Fifteen stereoscopic pairs of dust, footprints, and rocks were taken in the vicinity of the lunar module by the closeup camera. They show discoloration and shadowing indicating direction of scouring flow, cracks suggestive of a crust, clumps of powder possessing a variety of shapes, and glazed impact holes of 0.5 to 3 mm in size. — JHF

05113 **Gold, T.** Lunar theory and processes — Chemical observations by Surveyor V, *in* Surveyor final reports: Icarus, v. 12, no. 2, p. 224-225, 1970.

Arguments against widespread differentiation on the Moon are given: a chemical composition different from that of Earth, lack of central condensation, low gas emission, lack of horizontal deformation, and widespread stratification on the surface. — JHF

04955 **Goldstein, Robert F.** Correlation of Silurian strata between Georgia, Alabama, and Florida based on chitinozoan biostratigraphy [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1784, 1970.

Goodell, H. G. *See* Kunzler, R. H. 04737

04802 **Gordon, Bryan C.** *Bison antiquus* from the Northwest Territories: Arctic, v. 23, no. 2, p. 132-133, illus., table, 1970.

A partial skull of a bison, with horn cores much larger than those of modern bison, was found on the Liard River 3 mi above the mouth of the Blackstone River in Northwest Territories. On the basis of craniometrics and photo-interpretation, it has been identified as *Bison antiquus*; its measurements, compared with several species, are tabulated. It was half buried near the water's edge at the base of a 60-ft bank of alluvial sand and silt, which is underlain by a stratum of blue clay. Its excellent condition suggests it had not been transported far, but no attempts have been made to date to locate other parts of the skeleton *in situ*. This is the most northerly recorded occurrence of the species. — GDC

Gordon, Richard F. *See* Bean, Alan L. 05105

04479 **Gornitz, Vivien; Kerr, Paul F.** Uranium mineralization and alteration, Orphan Mine, Grand Canyon, Arizona: Econ. Geology, v. 65, no. 7, p. 751-768, illus., tables, 1970.

This uranium orebody occurs in a circular, vertical pipe structure, from 150 to 500 feet in diameter, extending downward from lower Coconino Sandstone into the Supai Formation and possibly the Redwall Limestone. Pipe fill consists of downward displaced Coconino Sandstone, siltstone, shale and limestone breccia from the Supai and Hermit Formations. There is no intrusive material and, therefore, a direct igneous origin is unlikely; it probably formed by solution collapse. Uranium ore is concentrated along the pipe border and in irregular masses within the pipe. Uraninite and pyrite at the center grade into a complex mixture of chalcocite, tennantite, chalcopyrite, galena, and uraninite at margins. Temperatures of ore depositions, suggested by fluid-inclusions in calcite, were 60-100°C; the minimum U-Pb age is 141 m.y. Sulfur isotope ratios are enriched in S-32 over S-34. Pipe structure and mineral distribution suggest a hydrothermal origin. — *from* Authors' abstract

04547 **Gose, Wulf Achim.** Palaeomagnetic studies of Miocene ignimbrites from Nevada: Royal Astron. Soc. Geophys. Jour., v. 20, no. 3, p. 241-252, illus., table, 1970.

A detailed paleomagnetic study of the Swett ignimbrite from Condor Canyon, Nevada, shows marked variations in intensity, direction, Koenigsberger ratio Q, and direction of magnetization. The variations in intensity and Q can be explained partly on the basis of grain size variations. A second profile through the same flow shows very different directions. Samples from six additional ignimbrites in the same sequence were studied; four are normally magnetized and two reversely. The paleomagnetic poles of two of these lie at 33° N and 49° N, the others within 20° of the rotational pole. Six of the ignimbrites have K-Ar ages between 29.7 and 17. 8 m.y. The anomalous pole positions may indicate large secular variations and may thus reflect another characteristic of the great instability of the geomagnetic field during the Tertiary. Another possibility is that these rocks record an intermediate direction acquired during a polarity transition. — DBV

04749 **Gould, Joseph C.; Langford, N. Gerald; Mott, Charles J.** Study guide for audio-tutorial earth science: Minneapolis, Minn., Burgess Publishing Co., sections paged separately, illus., tables, 1970.

Units in this study guide are: weather elements, weather forecasting, minerals, rocks, topographic maps, erosion, structure, introduction to astronomy, solar system, Moon and space travel, and the universe. — MCM

Grasty, R. L. *See* Darnley, A. G. 04528

04615 **Green, E. Jewett.** On the perils of thermodynamic modelling: Geochim. et Cosmochim. Acta, v. 34, no. 9, p. 1029-1033, table, 1970.

Considerable geochemical application can be made of component activity data for crystalline mineral solutions. As such data is very difficult to obtain directly, several workers have devised schemes for generating thermodynamic data which is consistent with available phase equilibria information. This note demonstrates that different phase diagram decomposition models yield very different thermodynamic data sets which may be equally consistent with the phase equilibria. — Author's abstract

Green, J. C. *See* Morey, G. B. 04971

Greenwood, J. C. *See* Greenwood, W. R. 05018

05018 **Greenwood, W. R.; Greenwood, J. C.** Experimental error in zircon crystal shape measurements: Jour. Geology, v. 78, no. 5, p. 576-580, tables, 1970.

An analysis-of-variance experiment of zircon crystal size and shape measurements shows that variability between operators is not a significant factor in distinguishing between morphology classes of zircon crystals from a single rock. — Authors' abstract

04924 **Greer, Raymond T.** Thermoluminescence-chemical composition correlations for meteoritic enstatite: Materials Research Bull., v. 5, no. 10, p. 765-770, illus., 1970.

Relationships between total thermoluminescence output and elemental composition for a single phase, enstatite ($MgSiO_3$), were sought for enstatite chondrite and achondrite meteorite specimens. The total thermoluminescence output of meteoritic enstatite was found to be inversely proportional to the amount of iron in the material and independent of the Ca and Mn. No significant correlation for thermoluminescence intensity was found with respect to cosmic ray exposure ages or natural radioactivity. This compositional dependence for thermoluminescence response indicates several limitations on using thermoluminescence as a stratigraphic analytical technique for lunar silicate materials. — Author's abstract

05009 **Gregor, B.** Denudation of the continents: Nature, v. 228, no. 5268, p. 273-275, illus., table, 1970.

Judson (1968) concluded that man's intervention has increased the overall denudation rate from 9 to 24 billion tons of sediment a year, far more than enough to discredit the present rate as a geological parameter to be extrapolated backwards over geologic time. This communication attempts to verify Judson's pre-human estimate and to defend its applicability to the past 300 m.y. Estimates of denudation rate are summarized in a table; there is fair agreement of three independent pre-human rates, and no obvious sign of drastic variations since the Carboniferous. Before then the rate could have been greater by a factor of 4, possibly on account of the absence of plant cover, but evidence for this is inconclusive. — DBV

Griggs, Allan B. *See* King, Elizabeth R. 04595

Grimes, D. J. *See* Harrison, J. E. 04514

04534 **Gross, G. A.** Geological concepts leading to mineral discovery: Canadian Mining Jour., v. 91, no. 4, p. 51-53, 1970.

Study of the origin of iron-formations in volcanic rocks has developed an appreciation of the association of base-metal sulfide mineral facies and their zonal relationships to ancient centers of volcanism. Discovery of sulfide deposits in the Canadian Shield confirms the concept and predictions about volcanic-sedimentary origin of stratiform sulfide deposits and their relationship to other types of iron formation. Increasing attention should be given to sedimentary environments for black shales and carbonate rocks, as these are important domains for many metals. Manganese nodules in ocean and fresh-water lake environments suggest possibilities for similar important deposits in older rocks. A high sulfur content in mafic igneous rocks is an important factor in appraisal of such rock bodies as a source of nickel sulfide minerals. — *from* Author's abstract

04695 **Gross, G. A.** Nature and occurrence of iron ore deposits, *in* Survey of world iron ore resources, occurrence and appraisal: New York, United Nations Dept. Econ. and Social Affairs, p. 13-31, illus., tables, 1970.

A working classification of iron deposits is presented in a table, and characteristics of the three main types, bedded, massive, and residual, and their subdivisions are summarized as a guide to their geology. More specific information is included in papers describing iron resources in each country. Characteristic features of iron-formations and their facies are described at some length. A section on the mineralogy of iron ores includes a table of the common iron minerals with descriptive information commonly used. — ESL

04697 **Gross, G. A.** Iron ore deposits of Canada and the West Indies, *in* Survey of world iron ore resources, occurrence and appraisal: New York, United Nations Dept. Econ. and Social Affairs, p. 237-269, illus., 1970.

In Canada, Clinton-type iron beds are the principal types in the Appalachians; ilmenite, magnetite, and titaniferous magnetite are typical of the Grenville belt. The Labrador geosyncline is a major belt, with Lake Superior type iron-formations. The southern Canadian Shield contains belts of Archean rocks with Algoma-type iron-formations; in the north, principal sources are Lake Superior type formations around Hudson Bay, Algoma-type in Archean belts, and hematite and magnetite on the north end of Baffin Island. In the Western Plains, some minette-type deposits and iron-rich sandstones occur. In the Cordillera, some small contact-metasomatic magnetite deposits are mined along the coast; no important deposits are known in the western Arctic Islands. Ore deposits of Cuba are lateritic or replacement. In the Dominican Republic, near Hatillo, magnetite masses have replaced limestone. — ESL

Groves, H. Leon, Jr. *See* Raup, Omer B. 04643

Haas, J. Eugene. *See* Kates, Robert W. 04961

Haas, J. Eugene. *See* Norton, Frank R. B. 04963

Haas, J. Eugene. *See* Norton, Frank R. B. 04964

04608 **Habib, Daniel.** Middle Cretaceous palynomorph assemblages from clays near the Horizon Beta deep-sea outcrop: Micropaleontology, v. 16, no. 3, p. 345-379, illus., tables, 1970.

A total of 76 species of spores and pollen and 30 species of dinoflagellate cysts and acritarchs are reported from clays of five piston cores collected from the submarine outcrop of beds stratigraphically near Seismic Reflector Horizon Beta. These well-preserved assemblages are considered to be of Middle Cretaceous age (Albian and Cenomanian). The number of types and individuals of palynomorphs, the latter ranging from approximately 4,000 to 40,000 per gram of dried sediment, their close quantitative relationship with Middle Cretaceous assemblages from the Atlantic Coastal Plain of the United States, and the inferred paleoecology of acanthomorphitid acritarchs all suggest a source area originally fairly close to the locus of deposition. — Author's abstract

04691 **Hadley, Jarvis B.; Nelson, Arthur E.** Caesars Head Quartz Monzonite in the western Carolina Piedmont, *in* Changes in stratigraphic nomenclature by the U.S. Geological Survey, 1969: U.S. Geol. Survey Bull. 1324-A, p. A23-A24, 1970.

04825 **Halbouty, Michel T.** Exploration geologist in the seventies [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1784-1785, 1970.

04681 **Hales, A. L.; Roberts, J. L.** Shear velocities in the lower mantle and the radius of the core: Seismol. Soc. America Bull., v. 60, no. 5, p. 1427-1436, illus., table, 1970.

Two S-velocity models for the lower mantle are derived from the S-traveltimes recently reported by Hales and Roberts [1970]. Observations of the difference in traveltime of S and ScS are reported. On the basis of these observations it is estimated that the radius of the Earth's core is (3489.92 ± 4.66) km for one velocity model and (3486.10 ± 4.59) km for another. — Authors' abstract

Hallinger, Donald E. *See* Haun, John D. 04649

04647 **Halls, Chris; Stumpfl, E. F.** Geology and ore deposition, Western Kerr Lake Arch, Cobalt, Ontario, *in* Mining and petroleum geology — Commonwealth Mining and Metall. Cong., 9th, United Kingdom, 1969, Proc., V. 2: London, Inst. Mining and Metallurgy, p. 241-284, illus., tables, 1970.

Results of structural, petrologic, and mineralogic investigations are correlated for a synthesis of factors responsible for mineralization in Western Kerr Lake Arch. Main lithologic units are Keewatin volcanic-sedimentary sequence, a diamictic Huronian sedimentary succession, and Nipissing diabase. Brittle fracturing and vein development in Huronian sediments is attributed to tectonic reactivation associated with Penokean and/or Grenville orogenies. Rich silver mineralization occurs in ENE-WSW striking structures in Kerr Lake Arch. Distinct mineral associations are attributed to four structurally defined vein types. Economically significant silver phases are three-phase intergrowths with up to 8 percent Hg and 13 percent Sb. It is proposed that these deposits are products of remobilization of metal concentrations in older Precambrian basement during Penokean and Grenville orogenies. — *from* Authors' abstract

04887 **Hamilton, Wayne L.** Atmospheric dust records in permanent snowfields, implications to marine sedimentation — Discussion [of paper by H. L. Windom, 1969]: Geol. Soc. America Bull., v. 81, no. 10, p. 3175-3176, illus., 1970.

For the paper under discussion *see* ibid., v. 80, no. 5, p. 761-782, 1969; Abs. North American Geology, September 1969.

Han, J. *See* Gelpi, E. 04602

04931 **Hansen, Robert E.** Geology and ground-water resources of Linn County, Iowa: Iowa Geol. Survey Water-Supply Bull. 10, 66 p., illus., tables, geol. map, 1970.

Ground water is the source of all municipal, farm and domestic, livestock, and most industrial supplies in Linn County which used an estimated 24 mgd in 1964. The principal aquifers are alluvium, buried channel deposits, Silurian-Devonian limestones and dolomites, and the Jordan Sandstone. All yield fair-to-good quality water, although the water is hard and locally contains high concentrations of iron. All are capable of yielding 500 gallons or more per minute to wells. Shallow bedrock and glacial drift aquifers yield only small quantities of good quality water and are suitable for the development of small supplies for domestic and livestock use. — *from* Author's abstract

05098 **Hapke, Bruce.** Inferences from the optical properties of the Moon concerning the nature and evolution of the lunar surface, *in* Symposium on planetary atmospheres and surfaces, Woods Hole, Mass., 1969: Radio Sci., v. 5, no. 2, p. 293-299, illus., 1970.

The unusual optical properties of the Moon are summarized. They imply that the fine-grained, compressible material observed by the Surveyor television cameras is representative of the entire lunar surface and very probably of the surfaces of Mercury, Mars, and the asteroids also. The soil is the result of repeated meteorite impacts and is not an ash flow. Evidence for darkening is examined, and it is concluded that a process is acting on the lunar surface to alter the albedo and color of the rock powder. Materials of chondritic or granitic composition are not prevalent on the Moon. Differences in the optical properties of the maria and the highlands imply that the soil cover is thicker in the highlands than in the maria and that the highland soils are laterally more homogeneous than are those of the maria. — Author's abstract

04790 **Harbaugh, John W.; Bonham-Carter, Graeme.** Computer simulation in geology: New York and London, Wiley-Interscience, 575 p., illus., tables, 1970.

04937 **Hardt, William F.; Hilton, George S.** Water resources and geology of Gloucester County, New Jersey: New Jersey Div. Water Policy and Supply Spec. Rept. 30, 130 p., illus., tables, geol. map, 1970.

Gloucester County in the Coastal Plain province is underlain by Cretaceous-Quaternary unconsolidated sand and clay which overlie Precambrian(?) metamorphic and igneous rocks. Water sufficient for domestic and farm supplies is available anywhere; however, moderate to large amounts can be pumped economically only from the Raritan and Magothy Formations, Cohansey Sand, Wenonah Formation and Mt. Laurel Sand. The Cretaceous Raritan-Magothy aquifer yields about 75 percent of ground water used (up to 1,400 gpm); the Tertiary Cohansey Sand has the greatest potential for future development; and the Wenonah-Mt. Laurel is capable of yielding 100-200 gpm locally. Chemical quality of water is generally acceptable. — *from* Authors' abstract

04935 **Hardwick, W. R.** Fracturing hard rock with nuclear explosives and extraction of ore by a modified block-caving method: U.S. Bureau Mines Rept. Inv. 7391, 18 p., illus., tables, 1970.

Nuclear explosive fracturing has been suggested as a method to make hard rock amenable to extraction by a modified block-caving method. To evaluate this possibility, conventional and nuclear blasting practices are discussed, underground mining methods for large deposits and their costs are described, and the cost of fracturing ore with a nuclear explosive and subsequent mining by a modified caving system is estimated and compared with open-stope and block-caving costs. While the direct cost of fracturing the ore in hard rock with a nuclear explosive is less than with conventional explosives, additional costs imposed by the use of nuclear explosives may make their use unattractive for deep mining. — Author's abstract

04523 **Harrington, John W.** Ontology of geologic reasoning with a rationale for evaluating historical contributions: Am. Jour. Sci., v. 269, no. 3, p. 295-303, 1970.

This paper contains a rationale and methodology by which isolated geological writings from any period may be evaluated as historically significant benchmarks of scientific understanding. The rationale rests on the case that there is a singular state

of nature toward which all estimates of reality converge. Evaluation is a measure of degree of correspondence between historical treatment of data and conclusions with those of our own times. Geologic reasoning in this context is founded on the parameters (1) position in space, (2) identification and classification of materials, (3) chronologic relations — all subject to direct measurement —, and (4) genetic relationships, the most logical inferences. A general expression for this system is given and is treated through a series of refinements to show that the pattern of reasoning seen today structuring scientific revolutions was duplicated in many ancient writings. — *from* Author's abstract

04826 **Harris, John F.** Search for the subtle clue — Carbonate exploration in the seventies [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1785, 1970.

04508 **Harris, L. D.; Mixon, R. B.** Geologic map of the Howard Quarter quadrangle, northeastern Tennessee: U.S. Geol. Survey Geol. Quad. Map GQ-842, scale 1:24,000, section, text, 1970.

Mineral resources of the Howard Quarter quadrangle are zinc, limestone and dolomite suitable for road metal, building stone, and small amounts of sand. Rapid rock analysis of two samples of limonite indicates that Fe_2O_3 ranges from 49.5-52.9 percent and phosphate from 0.20 to 0.55 percent. — MCM

04491 **Harrison, C. G. A.** Magnetization of Atlantic seamounts: Bull. Marine Sci., v. 20, no. 3, p. 560-574, illus., tables, 1970.

It is possible to infer direction of magnetization in a seamount from its shape and associated magnetic anomaly. Such a direction is equivalent to a paleomagnetic direction established by standard methods of measuring direction of magnetization of oriented rock samples. The result of applying this analysis to some seamounts in the Gulf of Guinea is described. By calculating the paleomagnetic pole position from the direction of magnetization in the seamounts, and comparing it with African paleomagnetic pole positions, it is shown that the concept of plate tectonics is obeyed, in that there seems to have been no relative motion between Africa and the Gulf of Guinea since the latter was formed during the opening of the Atlantic Ocean. Likewise, previously published paleomagnetic results from the Kelvin group of seamounts agree with North American paleomagnetic results. — *from* Author's abstract

Harrison, Frank W., Jr. *See* Lafayette Geological Society. 04752

04771 **Harrison, Frank W., Jr.** Maurice Field, Lafayette and Vermilion Parishes, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 19-19c, illus., 1970.

04514 **Harrison, J. E.; Grimes, D. J.** Mineralogy and geochemistry of some Belt rocks, Montana and Idaho: U.S. Geol. Survey Bull. 1312-O, p. 01-049, illus., tables, 1970.

The mineralogy and geochemistry of about 20,000 feet of Belt rocks in the Mission Mountains Primitive Area, northwestern Montana, are compared with those of about 40,000 feet of Belt rocks in the Pend Oreille area, northern Idaho and northwestern Montana. Most rocks are graywacke, and clastic from both areas are very similar, even to the ratio among quartz, potassium feldspar, and plagioclase in siltites. Trace-element abundance is related primarily to abundance of illite-chlorite-sericite in the various rock types. Variations in trace-element abundance between the two areas is attributed to variations in original source terrane. The abundance and distribution of minor amounts of copper identified in this study may aid in the search for stratabound copper deposits in Belt rocks. — JEH

Harrison, Jack E. *See* King, Elizabeth R. 04595

Harry, W. T. *See* Emeleus, C. H. 04987

04483 **Harshman, E. N.; Bell, Kenneth G.** Uraninite-bearing contact metamorphic deposits, Heaths Peak, Carbon County, Wyoming: Econ. Geology, v. 65, no. 7, p. 849-855, illus., 1970.

Deposits that contain uraninite and sulfide minerals at Heaths Peak, Carbon County, Wyo., display a zoned distribution of metals from the edge of granite into adjacent metamorphic rocks. The metallic minerals — uraninite, molybdenite, pyrite, chalcopyrite, galena, pyrrhotite, and marcasite — are concentrated on the undersides of metamorphosed roof pendants. At the Little Man mine, deposition was related to a small cupola projecting into the central part of an elongate pendant. The host rocks and the deposits are of Precambrian age. — Authors' abstract

05118 **Harvalik, Z. V.** A biophysical magnetometer-gradiometer: Virginia Jour. Sci., v. 21, no. 2, p. 59-60, 1970.

The sensitivity of man to magnetic fields can be determined by exposing subjects to magnetic fields produced by electric currents (AC or DC) of varying intensities passing through damp ground. The lower the intensity of the current, thus of the magnetic field, required to produce reaction of the subject, the greater is his sensitivity to magnetic field changes. A reaction is observed only when the negative electrode is his heart side. About 80 percent of the subjects tested showed pronounced sensitivity toward magnetic field changes. Some applications of this biophysical phenomenon are discussed [locating buried rocks, caves, root systems, flowing water. The dowser probably cannot determine causes of the magnetic disturbances]. — *from* Author's abstract

04559 **Hass, John L., Jr.** Fugacity of H_2O from 0° to 350°C at the liquid-vapor equilibrium and at 1 atmosphere: Geochim. et Cosmochim. Acta, v. 34, no. 8, p. 929-932, table, 1970.

The fugacity and fugacity coefficient of H_2O at the liquid-vapor equilibrium, the fugacity and the Gibbs free energy of formation of H_2O at 1 atm (1.01325 bars) total pressure have been calculated from published data on the physical and thermodynamic properties of H_2O and are presented at ten-degree intervals from 0° to 350°C. — Author's abstract

04765 **Hauck, Raymond J.** Holmwood-South Manchester, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 13-13d, illus., 1970.

04531 **Haugh, I.** Manitoba exploration 1970 — Retrospect and prospects: Canadian Mining Jour., v. 91, no. 4, p. 69-72, illus., 1970.

History of the mineral industry in Manitoba beginning with extraction of salt from brine springs in 1800 is reviewed. Around the turn of the century, gold prospecting began, with the first discovery in 1911. Total value of mineral production for 1969 was almost 246 million dollars. The Flin Flon-Snow Lake and Lynn Lake-Ruttan Lake areas, and Manitoba nickel belt explorations and developments are reviewed. History of the geological programs of the Manitoba Mines Branch, Geology Division, in the past, and future projects are discussed. — ESL

04649 **Haun, John D.; Barlow, James A., Jr.; Hallinger, Donald E.** Natural gas resources, Rocky Mountain region: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 9, p. 1706-1718, illus., tables, 1970.

In the Uinta-Piceance, Green River, Laramie-Hanna, Big Horn, and Powder River basins, 191,000 cu mi of Cretaceous and Tertiary rocks contain 10 trillion cu ft of gas (reserves plus past production), and 90,000 cu mi of pre-Cretaceous sedimentary rocks contain less than 1 trillion cu ft of gas. Cretaceous-Tertiary rocks occupy about 96,200 sq mi, of which only 9,050 sq mi (9.4 percent) has at least one well per square mile. Ten trillion cu ft of gas has been discovered by drilling wells in less than 10 percent of the available area. Less than 5 percent of available rock volume has been explored. If the gas originally in place were 10 times the gas discovered, the ultimate potential would be 100 trillion cu ft. — from Authors' abstract

04847 **Haun, John D.; Kent, Harry C.** Geologic history of Rocky Mountain region, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 1-20, illus., reprinted 1970; originally published 1965.

This paper was published originally in Am. Assoc. Petroleum Geologists Bull., v. 49, no. 11, p. 1781-1800, 1965. *See* Abs. North American Geology, April 1966. — ESL

Hauser, Victor L. *See* Lehman, Oliver R. 05058

Hazelhoff-Roelfzema, B. H. *See* Summerhayes, C. P. 04902

Heard, Hugh C. *See* Carter, Neville L. 04741

04886 **Heath, G. Ross; Culberson, Charles.** Calcite — Degree of saturation, rate of dissolution, and the compensation depth in the deep ocean: Geol. Soc. America Bull., v. 81, no. 10, p. 3157-3160, illus., 1970.

The hydrographic features that appear to control the distribution of calcite in deep-sea sediments are the level at which the water passes from super- to undersaturation, and the level at which the rate of dissolution increases abruptly (the lysocline). The compensation depth results from a roughly linear increase in the rate of solution of calcite with depth below the lysocline. It does not correspond to a unique physiochemical change within the water column. — Authors' abstract

04673 **Hecht, Alan D.; Savin, Samuel M.** Oxygen-18 studies of Recent planktonic Foraminifera — Comparisons of phenotypes and of test parts: Science, v. 170, no. 3953, p. 69-71, table, 1970.

Oxygen isotopic comparisons of phenotypes of Recent planktonic Foraminifera with both normal and diminutive final chambers are compatible with a model in which the latter develop as a response to environmental stress. Isotopic evidence shows that *Spheroidinella dehiscens* is probably not a late-stage, aberrant form on *Globogerinoides sacculifer*. — Authors' abstract

04545 **Hedberg, Hollis D.** Stratigraphic boundaries — A reply: Eclogae Geol. Helvetiae, v. 63, no. 2, p. 673-684, illus., 1970.

In reply to a recent paper by Wiedmann (ibid., v. 61, no. 2, p. 321-386, 1968) criticizing the position of the International Subcommission on Stratigraphic Classification, the following points are reemphasized: (1) In addition to those based on fossils, there are many kinds of stratigraphic units which sould be recognized in portraying the Earth's stratigraphic sequence and history. (2) Chronostratigraphic units are basic to grasping earth history. (3) A biostratigraphic unit is fundamentally different from a chronostratigraphic unit. (4) It is appropriate that standards for division points of geologic time should be referred to designated points in the sequence of rock strata-boundary strato-types. (5) There is nothing binding in the conclusions of the ISSC other than as they appeal to geologists in general as being in the interests of international understanding and progress. — DBV

04898 **Heinrichs, Donald F.** More bathymetric evidence for block faulting on the Gorda Rise: Jour. Marine Research, v. 28, no. 3, p. 330-335, illus., 1970.

A detailed bathymetric survey of the crest and axial valley of the Gorda Rise, between 41°10′ to 41°29′ N. and 127°15′ to 127°36′ W., has revealed several pronounced continuous benches. The most prominent benches are at depths of 2400 and 2800 m. The regional bathymetry is consistent with a block-faulting origin for the topography of the Gorda Rise. — Author's abstract

04504 **Heirtzler, J. R.** The paleomagnetic field as inferred from marine magnetic studies, *in* Symposium on multidisciplinary studies of unusual regions of the upper mantle, Madrid, Spain, 1969, Proc.: Jour. Geomagnetism and Geoelectricity, v. 22, nos. 1-2, p. 197-211, illus., 1970.

Studies of magnetization of both the oceanic crust and oceanic sediments show essentially the same history of the geomagnetic field as that derived from study of volcanic rocks on land. Such comparisons are only possible for the last 4.5 m.y. Extending in time the geomagnetic field history from study of the oceanic crust permits mapping large-scale crustal movement. The possibilities of such movements being related to the generating mechanism of the geomagnetic field and to other global phenomena [suggesting that cyclic components of the Earth's motion — precessional and otherwise — may generate the magnetic field, spread ocean floors, drift continents, alter climate, and be responsible for continuous mountain building activity] is discussed. — *from* Author's abstract

Heisel, J. E. *See* Watkins, F. A., Jr. 04636

04746 **Henderson, John B.** Stratigraphy of the Archean Yellowknife Supergroup, Yellowknife Bay-Prosperous Lake area, District of Mackenzie (85 J/8, J/9): Canada Geol. Survey Paper 70-26, 12 p., illus., geol. map, 1970.

Six new formational names and two new group names are defined. The Archean Yellowknife Supergroup (previously group) in the Yellowknife Bay-Prosperous Lake area is subdivided into the volcanic Beaulieu Group and the sedimentary Duncan Lake Group. On the west side of Yellowknife Bay the Kam Formation (Beaulieu Group, basalt and andesite), is unconformably overlain by the Jackson Lake Formation (Duncan Lake Group, sandstone). East and north of the bay, the intermediate volcanic Duck Formation (Beaulieu) is conformably overlain by the Burwash Formation (Duncan Lake), turbidite of greywacke and slate. The Walsh Formation (Duncan Lake) overlies the Burwash Formation. Elsewhere the Walsh and Burwash are separated by the Banting Formation, a unit not assigned to either group. — *from* Author's abstract

04920 **Henry, Elvin F.** Soils of the Dismal Swamp of Virginia: Virginia Jour. Sci., v. 21, no. 2, p. 41-46, illus., 1970.

Soils of the Virginia section of the Dismal Swamp were mapped during a drought in 1952, with soil borings and exploratory pits made at regular intervals; characteristics such as color, particle size and arrangement, and consistency were carefully documented as a basis for classification into 7 categories. Mucky peat, varying in thickness over marine sand, silt, and clay, and occupying about three fourths of the total area, is described in detail; its deep phase in an area about half a mile wide completely surrounds Lake Drummond; four layers of peat vary in decomposition. Representative profiles of the other six soils are given in the appendix. Most unusual is an elevated soil island, "Smith Ridge," classified as Woodstone fine sandy loam, apparently a remnant of an older, higher paleosol; moderately well drained, it has no organic deposits which can be related to the encircling environment. — GDC

04763 **Hensarling, Larry.** Glenmora Field, Rapides Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 11-11c, illus., 1970.

04930 **Hershey, H. G.; Wahl, K. D.; Steinhilber, W. L.** Geology and ground-water resources of Cerro Gordo County, Iowa: Iowa Geol. Survey Water-Supply Bull. 9, 75 p., illus., tables, 1970.

The igneous or metamorphic Precambrian basement complex in Cerro Gordo County is overlain by consolidated sedimentary rocks of Precambrian through Cretaceous age and unconsolidated Quaternary sand, gravel and clay. Three major Pleistocene glacial advances covered all or part of the county and left behind till and related outwash deposits up to 125 feet thick. Holocene deposits are thin and scattered. Chief aquifers are the deep Cambrian sandstones, Jordan aquifer, St. Peter Sandstone, Devonian and Mississippian limestones and dolomites, glacial drift and interglacial deposits. Yields range from 10 gpm or more in glacial outwash or shallow bedrock to about 1,200 gpm in the Jordan aquifer. Ground water is of suitable chemical quality for domestic, industrial and municipal use and is the major source of water supplies. — *from* Author's abstract

Hershey, L. A. *See* Kelly, T. E. 04921

Hewett, D. F. *See* Dibblee, T. W., Jr. 04806

04463 **Higgins, Michael W.; Waters, Aaron C.** A re-evaluation of basalt-obsidian relations at East Lake fissure, Newberry caldera, Oregon: Geol. Soc. America Bull., v. 81, no. 9, p. 2835-2842, illus., table, 1970.

Andesite scoria, agglutinate, and small flows formed by thin lava gushes that erupted from East Lake Fissure on the north wall of Newberry Caldera carry numerous inclusions of platy rhyolite, partly melted platy rhyolite, and frothy obsidian. This association of obsidian and "basalt" has been interpreted as the result of intermingling of mafic and siliceous magmas. The locality has been repeatedly cited as an example of a mixed intrusion of the "basalt-rhyolite association." Field, petrographic, chemical, and experimental evidence suggests, however, that the inclusions of frothy and massive obsidian are melted fragments of platy rhyolite which were ripped from a rhyolite unit forming part of the caldera wall by uncontaminated andesite magma which rose and fountained from the fissure. — Authors' abstract

Hill, Dorothy. *See* Jell, J. S. 04707

Hilton, George S. *See* Hardt, William F. 04937

04495 **Hinton, Richard J.** The hand-book to Arizona — Its resources, history, towns, mines, ruins and scenery (amply illustrated, accompanied with a new map of the territory): Glorieta, N. Mex., Rio Grande Press, [593] p., illus., reprinted 1970; originally published 1878.

Of particular interest to geology are the chapters on physical and geological features; mineral resources; and mines, mills, and locations. — MCM

04804 **Hiss, W. L.** Acquisition and machine processing of saline water data from southeastern New Mexico and western Texas, *in* Saline water symposium: Water Resources Research, v. 6, no. 5, p. 1471-1477, illus., 1970.

Approximately 20,000 saline water analyses obtained from oil companies operating in the Delaware basin were indexed to the Permian Basin Well Data System magnetic tape file, coded, punched into tabulating cards, and stored on magnetic tape for computer operations. Location and operator indexes prepared from the PBWDS file were absolutely essential to efficient machine data-processing operations. Extensive manual and computer error checks for duplication and accuracy were made to eliminate data errors resulting from poorly located or identified samples; nonrepresentative or contaminated samples; mistakes in coding, reproducing, or keypunching; laboratory errors; and inconsistent reporting. The original analyses considered were reduced to approximately 9000 representative analyses. Compiled data were used in a study of saline water resources of the Permian Artesia group and Capitan and San Andres limestones. — *from* Author's abstract

04565 **Hite, Robert J.** Shelf carbonate sedimentation controlled by salinity in the Paradox Basin, southeast Utah, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 48-66, illus., table, 1970.

Each complete Middle Pennsylvanian evaporite cycle in the Paradox basin of Utah and Colorado consists of a transgressive and a regressive hemicycle bounded by disconformities; beds comprising these cycles grade shelfward into predominantly carbonate facies. Salinities of the evaporite basin controlled carbonate sedimentation on the adjacent shelf. High sea level and related maximum reflux carried toxic brines onto the shelf and created unfavorable conditions for life and deposition of biogenic carbonates. Only during low sea level, with little or no reflux, were shelf conditions optimum for growth of algal bank carbonates. Using bromine distribution in halite units of evaporite cycles as an index of basin reflux, cycles favorable for development of carbonate facies can be predicted. Because these facies in many evaporite basins are major sources of petroleum, bromine geochemistry gains another use in exploration. — *from* Author's abstract

Hite, Robert J. *See* Dyni, John R. 04569

Hite, Robert J. *See* Raup, Omer B. 04643

04869 **Hoffman, David J.** Deformational effects on iron occurrence and ore potential at Queco: Econ. Geology, v. 65, no. 5, p. 583-587, illus., table, 1970.

In conjunction with evidence from the records of diamond drilling, bulk sampling, and geological-geophysical mapping, four aspects of a phenomenon whereby iron concentration increases toward the axes of major folds are discussed — namely that as fold axes are approached: (1) soluble iron content increases; (2) iron formation thickens; (3) relative proportions of iron formation to total stratigraphic section increase until the iron formation constitutes a continuous section; (4) grain of ore minerals coarsens. — Author's abstract

04772 **Hoffmann, Edward A., Jr.** Mud Lake and Second Bayou Fields, Cameron Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 20-20f, illus., 1970.

Hofman, George. *See* Minch, John A. 04885

04941 **Hogarth, D. D.** Geology of the southern part of Gatineau Park, National Capital region: Canada Geol. Survey Paper 70-20, 8 p., geol. map, 1970.

A positive wedge of Precambrian rocks between the lowlands along the Ottawa and Gatineau Rivers is described. Most rocks show some degree of regional metamorphism imposed during the Grenville Orogeny; 11 units are mapped of which five are of probable igneous origin. Three units of Middle Ordovician sedimentary rocks are discussed also. The plunge of fold axes varies from east to west at low angles to 45° northeast, and axial planes trend east-northeast with steep dips. Linears have two principal directions: east-northeast and west-northwest, the latter being younger. Large faults are marked by discontinuous shatter zones. Raised terraces and beaches of the Champlain Sea are well preserved in the eastern part of the area. No mining is now conducted in Precambrian rocks, but Paleozoic limestones and Recent deposits of sand and gravel are mined in the lowlands. — ESL

04785 **Hohmann, Gerald W.; Kintzinger, Paul R.; VanVoorhis, Gerald D.; Ward, Stanley H.** Evaluation of the measurement of induced electrical polarization with an inductive system: Geophysics, v. 35, no. 5, p. 901-915, illus., 1970.

An airborne induced polarization method is a theoretical possibility. Calculations based on a conductivity model determined experimentally at frequencies less than 30 hz suggest that the effect of polarizable material on electromagnetic response is quite small. In order to check the theory and to determine experimentally whether inductive IP is feasible, field tests were conducted in two areas in Nevada which exhibit strong conventional IP anomalies. The presence of the polarizable material is not evident in the inductive data; in fact, the observations can be fitted to theoretical curves for nonpolarizable models. Hence, on the basis of both theory and field tests, it is concluded that inductive IP based on amplitude measurements is not a practical exploration tool for environments such as that of the southwestern United States. — *from* Authors' abstract

04952 **Holcomb, C. Wayne.** Future petroleum provinces of Gulf Coast, Upper Cretaceous [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1785, 1970.

Holliday, Barry W. *See* Swift, Donald J. P. 04724

Holmes, John. *See* Bell, John. 04758

05109 **Holt, H. E.; Rennilson, J. J.** Preliminary geologic investigation of the Apollo 12 landing site — Pt. B, Photometric and polarimetric properties of the lunar regolith, *in* Apollo 12 preliminary science report: U.S. Natl. Aeronautics and Space Adm. Spec. Pub. SP-235, p. 157-161, illus., 1970.

Photometric and polarimetric studies related to the Apollo 12 landing include condition of the Surveyor 3 footpad imprints and lunar material disturbed by the Surveyor

surface sampler, nature of the lunar photometric function at the centimeter scale, and comparison of the macroscopic textures of the surface with the observed photometric function. Albedo measurements of disturbed and undisturbed materials taken by Surveyor 3 and Apollo 12 astronauts indicate little change in the site materials in the 30 months since Surveyor 3. Only minor changes, notably color, occurred in the Surveyor craft. Polarization measurements show observed rocks to differ from one another and from fine-grained materials in polarizing properties. — JHF

05092 **Holt, Henry E.** Photometry and polarimetry of the lunar regolith as measured by Surveyor, *in* Symposium on planetary atmospheres and surfaces, Woods Hole, Mass., 1969: Radio Sci., v. 5, no. 2, p. 157-170, illus., 1970.

High resolution measurements (centimeter scale) revealed differences in the photometric functions of various materials concomitant with probable different fine-scale surface textures. The polarimetric function of lunar soil is similar to that of basalt and gabbro powdered to a grain size of 30 to 75 μ. Lunar rocks reflecting strongly polarized light (up to 34 percent polarized) have the highest albedos. The observed polarimetric function of lunar rocks is more similar to that of basalt and gabbro than any other common rock types.—*from* Author's abstract

Hornbrook, E. H. W. *See* Allan, R. J. 04660

Hosman, R. L. *See* Cushing, E. M. 04550

04700 **Hotton, Nicholas, 3d.** *Mauchchunkia bassa*, gen. et sp. nov., an anthracosaur (Amphibia, Labrinthodontia) from the Upper Mississippian: Kirtlandia, no. 12, 38 p., illus., tables, 1970.

The skull, articulated presacral vertebral column, and several limb elements of an anthracosaurian amphibian from the lowest beds of the Mauch Chunk Group (Upper Mississippian) at Greer, West Virginia, are described as *Mauchchunkia bassa*, gen. et sp.nov., and made the type of a new family, the Mauchchunkiidae. In most respects the type resembles the Embolomeri, but the presacral column is short, the intercentrum is a ventrally placed crescent, the limbs are stout, and the snout is not elongate. *Mauchchunkia* appears to be the most generalized anthracosaur yet described, and in many of its features it supports the view that the primary adaptation of primitive tetrapods was toward a terrestrial environment. Vertebral structure foreshadows reptilian conditions, and the Mauchchunkiidae are proposed as early ancestors of all reptiliomorph tetrapods. — Author's abstract

Houser, B. L. *See* Empson, F. M. 04639

Housner, G. W. *See* Tsai, N. C. 04686

04718 **Howe, John A.** The range of variation in *Equus* (*Plesippus*) *simplicidens* Cope from the Broadwater quarries of Nebraska: Jour. Paleontology, v. 44, no. 5, p. 958-968, illus., tables, 1970.

The remains of a medium-sized Pleistocene horse are commonly found in the Broadwater fossil quarries [Lisco member of Broadwater Formation] of western Nebraska. It appears that a single species of the genus *Equus* is represented in these quarries. A statistical analysis of the range of variation in this species provides a basis for comparison with other early Pleistocene horse populations. A comparison of this range of variation with the published diagnostic characters of other horse species of the same geologic age indicates that most of the named species need to be revised, for their diagnostic characteristics as published can be duplicated in the Broadwater quarry population. — Author's abstract

Hradilek, P. J. *See* Duke, C. M. 04667

05025 **Hughes, Charles J.** The Heart Mountain detachment fault, a volcanic phenomenon, — A reply [to discussion by W. G. Pierce and W. H. Nelson, 1970]: Jour. Geology, v. 78, no. 5, p. 629-630, 1970.

For original paper, *see* ibid., v. 78, no. 1, p. 107-115, 1970; Abs. North American Geology, July 1970. For discussion by Pierce and Nelson, *see* ibid., p. 116-128; Abs. North American Geology, July 1970.

05124 **Hussain, M. S.; Swindale, L. D.** A morphological and mineralogical study of the gray hydromorphic soils of the Hawaiian Islands: Pacific Sci., v. 24, no. 4, p. 543-553, illus., tables, 1970.

Gray hydromorphic soils are imperfectly to poorly drained soils that occur on coastal fringes of the Hawaiian Islands on surfaces of Pleistocene to Recent age. Mottling is characteristic, and gley horizons occur in more hydromorphic soils in the group. As soils become hydromorphic, color values increase and structures deteriorate. Halloysite is the dominant clay mineral in the less hydromorphic soils and montmorillonite is dominant in the more hydromorphic soils, and is iron-rich. Hydrated halloysite occurs in all soils studies but is most abundant in the more hydromorphic soils. The trend of increasing montmorillonite and increasing hydrated halloysite with increasing hydromorphism is clearly related to pedogenic processes. — *from* Authors' abstract

Hussong, D. M. *See* Furumoto, A. S. 04925

Ibanez, J. *See* Oró, J. 05088

04543 **Iglehart, Charles F.** Descriptive classification of subsurface correlative tops: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 9, p. 1697-1705, illus., table, 1970.

Definitions and geologic diagrams for 21 types of tops or picks used by geologists working with subsurface stratigraphic correlations are presented to establish standards for distinguishing 'normal' correlative tops from 'estimated,' 'faulted,' and other types of tops. There is a logical relation among some of the types, and they are grouped into a six-part descriptive classification. For geologists who plan to use computers and automatic plotting devices in working with subsurface data [mostly mechanical well logs and sample work], unique three-letter abbreviations are recommended as computer codes for each type of top. — Author's abstract

Ingamells, C. O. *See* Engels, J. C. 04526

Inman, Douglas L. *See* Komar, Paul D. 04599

05024 **Isphording, Wayne C.** FORTRAN IV program for calculations of measures of central tendency and dispersion on IBM 360 computer: Jour. Geology, v. 78, no. 5, p. 626-628, table, 1970.

The FORTRAN IV program determines: (1) moment measures, (2) Folk and Ward statistical parameters, and (3) Inman's statistics by submitting the total sample weight and the weight retained on each sieve for a given sample. Any number of sieve intervals can be used and data needed to construct the cumulative frequency curve are printed. — *from* Author's abstract

Jackson, M. L. *See* Dolcater, D. L. 04674

04618 **Jacob, Klaus H.** Three-dimensional seismic ray tracing in a laterally heterogeneous spherical earth: Jour. Geophys. Research, v. 75, no. 32, p. 6675-6689, illus., table, 1970.

To explain the observed anomalous P and S traveltimes and attenuation phenomena associated with zones of mobile lithosphere descending into the mantle beneath island arcs, it is necessary to trace the body-wave paths through laterally inhomogeneous Earth models. A ray-tracing technique is developed here which uses Fermat's principle to obtain the differential equation of a ray in spherical coordinates. The position, direction, and traveltime of the wave front at any point along the curved ray path are obtained by numerical integration of the differential equation for an assumed three-dimensional, continuous velocity distribution. The problem of representing a realistic velocity structure in the Earth is solved in a way suitable for

computer use. Some examples are presented for rays traversing island arcs. Implications of the ray-tracing method for various seismic studies, and $dT/d\Delta$ measurements from large seismic arrays and their inversion to obtain details of upper mantle velocity structure, are discussed. — DBV

04478 **Jacoby, Charles H.** Faults in salt mines — Their impact on operations, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 447-452, illus., 1970.

Gravity faults have demonstrated a throw of 57 feet in the Cleveland [Ohio] area. The faults and their accompanying stress patterns force deviations from original mine layouts and create rock mechanics problems. The petrofabrics and in situ stresses associated with the fault systems can cause floor heave, roof slabbing, and pillar spalling. In order to achieve the most stable type of mine opening, the shape, size, and orientation of these openings must conform with the in situ stresses of the fault system. Other aspects of the problem are rate of penetration of drills, fragmentation of the salt, quantity of explosives required, and the amount of roof and rib scaling needed. — *from* Author's abstract

04776 **Jacques, T. E.** Rayne Field, Acadia Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 24-24d, illus., 1970.

04556 **Jain, A. V.; Lipschutz, M. E.** On preferred disorder and the shock history of chemical group IVA meteorites: Geochim. et Cosmochim. Acta, v. 34, no. 8, p. 883-892, illus., table, 1970.

We report the results of a metallographic and X-ray diffraction study of the shock history of 16 meteorites of chemical group IVA. Of these, 12 contain evidence for preterrestrial shock-loading to pressures of 130 kb or more. These results, together with previous ones, indicate that about 60 percent of the group IVA meteorites have been strongly shocked and thus that the collision which produced this group was particularly violent. The physical and chemical properties of these meteorites are consistent with their origin from a single Mars-crossing asteroid that was disrupted by collision with another object, tentatively identified with the parent body of a few hypersthene chondrites. In this event the shock-induced velocity impulse may have been helpful but not essential in causing these meteorites to be eventually captured by Earth. — Authors' abstract

04892 **Janke, N. C.** Intrusive sandstone dykes in the Siamo Slate near Negaunee, Michigan — Discussion [of paper by C. McA. Powell, 1969]: Geol. Soc. America Bull., v. 81, no. 10, p. 3179-3180, 1970.

For the paper under discussion *see* ibid., v. 80, no. 12, p. 2585-2594, 1969; Abs. North American Geology, May 1970.

04585 **Janssens, A.** Middle Devonian formations in the subsurface of northwestern Ohio: Ohio Div. Geol. Survey Rept. Inv. 78, 22 p., illus., tables, 1970.

In the study area in northwestern Ohio Middle Devonian rocks range stratigraphically from the Sylvania Sandstone, underlain by Silurian carbonates, to the Tenmile Creek Dolomite, overlain by the Ohio (Antrim) Shale. The formations lie directly below glacial deposits in a narrow outcrop belt. The Sylvania Sandstone has a restricted areal distribution and may reflect the position of an early Middle Devonian shoreline. The lower Dundee thins westward and is absent in the western part of the area. The lower part of the upper Dundee becomes a lithographic limestone west of the Lucas County outcrop. The name Traverse Formation is proposed for two members of the Traverse Group, the Silica Formation and the Tenmile Creek Dolomite above it which can no longer be differentiated. — EH

04582 **Jaron, Michael G.** Investigation of solution collapse breccia in mature salt cavities, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 422-428, illus., 1970.

Collapse features in an LPG storage cavity are compared with natural collapse features from a structure whose origin is believed contemporaneous with the deposition of the B and C units of the Michigan Salina occupying about 40 acres. About 200 feet of salt were removed from unit B. Bulking by collapsed insoluble ledges in the B salt section and about 50 feet of overlying unit C roof rock, plus a thickened undisturbed unit C dolomitic shale-anhydrite section account for the volume of salt removed. A structure map on the top of the C unit shows no evidence of the underlying solution, hence dating the event. It is thought that within reasonable limits, bulking will stabilize a salt cavity and thus serve to protect the overlying section from destructive subsidence. — *from* Author's abstract

Jeffries, J. D. *See* Morawski, F. P. 04801

04707 **Jell, J. S.; Hill, Dorothy.** A redescription of the holotype of the Devonian rugose coral *Utaratuia laevigata* Crickmay: Jour. Paleontology, v. 44, no. 5, p. 833-835, illus., 1970.

The holotype of the Canadian (southwestern Northwest Territories) Middle Devonian aseptate rugose coral *Utaratuia laevigata* Crickmay, the type species of *Utaratuia* Crickmay, is redescribed from new thin sections. It is probable that *Utaratuia* is a junior synonym of *Tabellaephyllum* Stumm of the subfamily Disphyllinae Hill of the family Phillipsastraeidae Roemer. — Authors' abstract

04702 **Jenkins, W. A. M.** Chitinozoa from the Ordovician Sylvan Shale of the Arbuckle Mountains, Oklahoma: Palaeontology, v. 13, pt. 2, p. 261-288, illus., tables, 1970.

Nine genera and 12 species (five new) are recorded from the Sylvan Shale of the Arbuckle Mts. The shale is Upper Ordovician throughout, and no *abrupt* changes break the general continuity of the chitinozoan succession, but on the basis of *gradual* changes in the chitinozoan fauna, three biostratigraphic units can be recognized. The fauna is recognizable in the Maquoketa of Iowa and in the subsurface of western Texas. It differs from the fauna of the underlying Fernvale and Viola Limestones and the overlying Silurian-Devonian Hunton Group. The fauna is described systematically. — HRC

Jensen, Lyle H. *See* Stout, George H. 04499

Jindal, Vinod K. *See* Martinez, Joseph D. 05030

05059 **Johnson, A. I.** Saline water symposium — Introduction: Water Resources Research, v. 6, no. 5, p. 1441, 1970.

This symposium, 'Saline water — A valuable resource,' was held in April 1969 during the 50th annual meeting of the American Geophysical Union in Washington, D.C. The objective was to provide a new perspective on the value of saline ground water and aquifers. Of the 15 papers, 11 are cited separately. — ESL

05036 **Johnson, Helgi; Smith, Bennett L.** (editors). The megatectonics of continents and oceans: New Brunswick, N. J., Rutgers Univ. Press, 282 p., illus., 1970.

The 12 papers in this volume, based mostly on lectures given at a symposium on continental drift at Rutgers University in 1966, provide a comprehensive account of the development of modern global tectonics since paleomagnetic information obtained in the mid-fifties made the theory popular again. The individual papers are cited separately. — VSN

Johnson, J. G. *See* Boucot, A. J. 04713

04970 **Johnston, Herbert E.** Ground-water resources of the Loysville and Mifflintown quadrangles in south-central Pennsylvania: Pennsylvania Geol. Survey Bull. W-27 (Water-Resources Rept.), 96 p., illus., tables, 1970.

The area is underlain by strongly-folded, deeply-weathered Ordovician to Devonian sedimentary rocks. Permeability of the 1- to 50-ft thick mantle is low, but storage

capacity is high. Most drilled wells tap only two or three significant water-bearing openings in the upper 100 feet of bedrock. Yields reported for more than 500 wells, 50 to 170 feet deep, range from < 1 to 275 gpm. Short-term specific capacities vary from < 0.1 to 62 gpm per foot and are high in wells in Late Silurian or Early Devonian calcareous shale and limestone in valleys. Principal yielding zones generally occur above a depth of about 200 feet. Water from wells in calcareous shales and limestones has a dissolved-solids content of 200 to 300 mg/l and is hard to very hard. — EH

Joiner, Thomas J. *See* Wilson, Gary V. 05068

Jones, F. P. *See* Berg, R. B. 04699

Jones, R. *See* Gold, T. 05111

Jones, Richard K. *See* Lafayette Geological Society. 04752

04871 **Kalliokoski, J.** Company geologists, students, and economic geology: Econ. Geology, v. 65, no. 5, p. 592-593, 1970.

Suggestions are made concerning ways in which mining company geologists can help to alleviate the shortage in mineral deposits oriented geologists by offering temporary employment to graduate students, in both field and laboratory assignments, that would provide thesis material. Results would be beneficial to both mining companies and to the students. — VSN

Kanasewich, E. R. *See* Clowes, R. M. 04734

05122 **Karup-Möller, S.; Brummer, J. J.** The George Lake zinc deposit, Wollaston Lake area, northeastern Saskatchewan: Econ. Geology, v. 65, no. 7, p. 862-874, illus., tables, 1970.

Quartzite boulders containing finely-disseminated sphalerite with minor galena, pyrite, and pyrrhotite form a glacial train 10 mi in length flanked by pyrite-bearing quartzite boulders along a length of 40 mi. Samples of sphalerite-bearing float assayed up to 14 percent Zn and 4.5 percent Pb. The source of the float was at the east side of the southwest end of George Lake where bedrock was covered by drift from 0-1000 feet thick. Surface drilling indicated a deposit of 5 million tons averaging 2.65 percent Zn and 0.35 percent Pb, including a higher grade core of 2.9 million tons averaging 3.67 percent Zn and 0.53 percent Pb. Trace-element content of the sphalerite indicates similarities with sphalerites from 'Mississippi Valley type' deposits. The sulfides are considered to be syngenetic. Metamorphism subsequently resulted in minor redistribution of ore minerals. — *from* Authors' abstract

04961 **Kates, Robert W.; Haas, J. Eugene.** General introduction, conclusions, and recommendations, *in* The great Alaska earthquake of 1964 — Human ecology: Washington, D. C., Natl. Acad. Sci., p. 1-4, 1970.

A national policy of reducing earthquake losses is needed. Programs should be combined with those of agencies who handle other more persistently-occurring disasters. Earthquake countermeasures should be carried on at the local level, and planning for postearthquake physical reorganization is especially important. Up-to-date earthquake and geologic-hazard maps, including tsunami hazard, are vitally important for land-use planning. The need for these and other human-response studies is emphasized as a result of the study of this great earthquake and its aftereffects. — HRC

05064 **Katz, Donald L.; Tek, M. Rasin.** Storage of natural gas in saline aquifers, *in* Saline water symposium: Water Resources Research, v. 6, no. 5, p. 1515-1521, illus., tables, 1970.

Value, extent, and engineering description of underground storage of natural gas in saline aquifers are reviewed. Problems associated with evaluation of aquifer storage

prospects, geologic and geochemical requirements have been discussed along with topics related to operation pressures, gas retention, and pump tests. — Authors' abstract

04457 **Kays, M. Allan.** Mesozoic metamorphism, May Creek Schist belt, Klamath Mountains, Oregon: Geol. Soc. America Bull., v. 81, no. 9, p. 2743-2758, illus., tables, geol. map, 1970.

The belt occupies about 300 sq mi and consists of regionally metamorphosed rocks of Triassic and Jurassic age together with granitic plutons and metamorphosed ultramafic-mafic rocks. Detailed mapping and petrographic studies in the northernmost part have established isograds; metamorphism is progressive, and grade increases toward the axis which includes the locus of granitic plutons and ultramafic-mafic rocks. Pattern of isograds indicate steep thermal gradients, suggesting granitic plutons supplied heat of metamorphism. Assemblages in pelitic rocks indicate metamorphism interpreted as intermediate between low pressure contact and higher pressure Barrovian-like metamorphism. — RAL

04799 **Kellogg, Karl; Larson, E. E.; Watson, D. E.** Thermochemical remanent magnetization and thermal remanent magnetization — Comparison in a basalt: Science, v. 170, no. 3958, p. 628-630, illus., 1970.

Recent studies have shown that the remanent magnetization carried by an extrusive igneous rock may not be entirely thermal remanent magnetization (TRM). Some may be thermochemical remanent magnetization (TCRM) acquired by the rock at temperatures at least as low as 300°C during oxidation of the contained titanomagnetite grains. Results from a study of a set of basaltic samples from one locality indicate that the intensity of TCRM acquired by a sample in a known magnetic field is equal to that of TRM subsequently produced in the same sample in the same field. On the assumption that the samples we studied are not magnetically unique, we tentatively conclude that paleointensity studies are valid in spite of the presence of TCRM, as long as the rock acquired the magnetization during the initial cooling. — Authors' abstract

Kelly, J. A. *See* Craig, D. B. 04529

04921 **Kelly, T. E.; Myers, B. N.; Hershey, L. A.** (and others). Saline ground-water resources of the Rio Grande drainage basin, pilot study — U.S. Office Saline Water Research and Devel. Prog. Rept. 560: Washington, D.C., U.S. Govt. Printing Office, 71 p., illus., table, 1970.

In a gross view, aquifers 3,000 feet below Albuquerque, New Mexico, and 1,500 feet below Brownsville, Texas, yield to individual wells more than 500 gal/min of water 1-3 gpl saline, a unit probably dimensionally sufficient to provide a long-term source for desalting. Most promising is the 3-10 gpl saline unit of similar well yields from the San Juan basin flank and upper Pecos area in New Mexico, and from the lower Rio Grande coastal plain sediments, the top in all three areas less than 1,000 feet below land surface; the Capitan reef complex in New Mexico would also sustain large yields. Water of 10-35 gpl salinity underlies 6,500 sq mi of the lower Rio Grande drainage basin; large volumes are also in the upper Pecos region and Jornada del Muerto and Estancia basin. Brine with over 35 gpl dissolved solids is in significant quantity in the Tularosa basin. In detailed investigations for desalting sites, brine disposal should be a major consideration. — GDC

Kennedy, E. Joyce. *See* Ruch, R. R. 04488

Kent, Harry C. *See* Haun, John D. 04847

Kern, John M. *See* Conkin, James E. 04515

04991 **Kerridge, J. F.** Meteoritic pyrrhotite: Meteoritics, v. 5, no. 3, p. 149-152, illus., 1970.

An opaque, lath-like mineral, commonly seen in thin sections of the Orgueil Cl carbonaceous meteorite, was recently identified as pyrrhotite by the electric probe; a formula of $(Fe,Ni)_{0.9}$ S was calculated. This and its identification in Revelstoke by means of X-ray diffraction support a prediction by Mason (1962) that pyrrhotite should be expected in the iron-free C I meteorites; it has also been identified as a constituent of some sulfide nodules in iron meteorites. The Orgueil pyrrhotite also occurs as plates, 10 to 100 microns in diameter. Faint birefringence in otherwise amorphous matrix leads to the conclusion that the region has undergone mild recrystallization. It is concluded that the sulfide grain was embedded at a significantly higher temperature than its matrix, with impact probably at a moderate velocity. — GDC

Kerr, Paul F. *See* Gornitz, Vivien. 04479

04827 **Kessler, L. G., 2d; Cooper, Fred G.** Channel sequences and braided-stream development in South Canadian River, Hutchinson, Roberts, and Hemphill Counties, Texas [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1786, 1970.

04919 **Kesten, S. Norman.** The Van Stone mine, Stevens County, Washington, [Chap.] 11 *in* Lead-zinc deposits in the Kootenay Arc, northeastern Washington and adjacent British Columbia — Soc. Econ. Geologists, 1970 Northwest Field Conf. Guidebook: Washington Div. Mines and Geology Bull. 61, p. 121-123, 1970.

The mine is in the Colville Mts. at the headwaters of Onion Creek. The deposit was first explored around 1925, and production began in 1952. Recent drilling has revealed additional mineralized bodies. Most deposits are replacements in carbonate rocks, but there are some vein-type deposits in noncalcareous rocks. The Spirit pluton consists of a central mass of porphyritic biotite granodiorite bordered by a nonporphyritic granodiorite, both cut by dikes. Ore bodies lie along an S-shaped fold between the Spirit pluton and the Rogers Mtn. fault. Host rock is a dolomite member of the Metaline Limestone. — ESL

04731 **Kienle, Jürgen.** Gravity traverses in the Valley of Ten Thousand Smokes, Katmai National Monument, Alaska: Jour. Geophys. Research, v. 75, no. 32, p. 6641-6649, illus., table, 1970.

Three structural sections across the pyroclastic flow of the 1912 Mount Katmai eruption in the Valley of Ten Thousand Smokes were derived from gravity data. Minimum average ash flow thicknesses of 40, 45, and 30 m were deduced for profiles across the main, the south, and the southeast branches of the valley, respectively. The total volume of the ash flow is estimated to be 3.8 to 4.7 km^3. — Author's abstract

Kiff, Irving T. *See* Worthington, Joseph E. 04958

05065 **Kimbler, Oscar K.** Fluid model studies of the storage of freshwater in saline aquifers, *in* Saline water symposium: Water Resources Research, v. 6, no. 5, p. 1522-1527, illus., 1970.

Flow studies in artificial sandstone models have been used to test and validate a computational technique for predicting the recovery of freshwater stored in saline aquifers. These studies indicate the physical and operational conditions under which such storage should be technically feasible, and show that gravitational effects are usually a much more important cause of poor freshwater recovery than is dispersion. — Author's abstract

04595 **King, Elizabeth R.; Harrison, Jack E.; Griggs, Allan B.** Geologic implications of aeromagnetic data in the Pend Oreille area, Idaho and Montana: U.S. Geol. Survey Prof. Paper 646-D, p. D1-D17, illus., table, geol. map, 1970.

An aeromagnetic survey of an 800-sq-mi area bounded on the west by Purcell trench and on the north by Hope fault shows that both exposed and buried Cretaceous granodiorite cupolas and stocks are associated with positive magnetic anomalies.

Magnetic properties studies were used to evaluate the size and shape of the masses producing the anomalies. Most of the host rocks are in the Belt Supergroup. The reticularity of some aeromagnetic contours is related to major block faults, reactivated during tectonic swelling and emplacement of granodiorite. Subsequent collapse created a block mosaic of minor faults within older blocks. The Magee fault zone, of closely spaced high-angle faults, developed when a long narrow pluton raised and tilted a block bounded on three sides by preexisting faults and formed a monocline on the fourth side which stretched and collapsed. The principal mining areas do not have a direct magnetic expression. — ERK

04727 **King, Lewis H.; MacLean, Brian.** A diapiric structure near Sable Island, Scotian Shelf: Maritime Sediments, v. 6, no. 1, p. 1-4, illus., 1970.

A diapiric structure was discovered on the Scotian Shelf at a point 45 km north-northeast of Sable Island in the Atlantic Ocean east of Nova Scotia, by means of continuous seismic-reflection techniques. The structure is dome-shaped, may contain an evaporitic core, and intrudes rocks considered to be of Cretaceous age. The area of the structural disturbance is at least 10 km in diamater. — Authors' abstract

04884 **King, Lewis H.; MacLean, Brian.** Pockmarks on the Scotian Shelf: Geol. Soc. America Bull., v. 81, no. 10, p. 3141-3148, illus., table, 1970.

Pockmarks are cone-shaped depressions that occur in large numbers across the LaHave Clay of the Scotian Shelf. They normally range in diameter from 15 to 45 m and in depth from 5 to 10 m. They were possibly formed by ascending gas or subsurface water leakage from underlying coastal plain sediments. — Authors' abstract

04939 **King, Lewis H.** Surficial geology of the Halifax-Sable Island map area: Canada Dept. Energy, Mines and Resources, Marine Sci. Br. Paper 1, 16 p., illus., geol. map, 1970.

This report that accompanies Chart 4040G (same title, available separately) contains information on the physiography of the Halifax-Sable Island map area, mapping methods, bedrock and surficial geology, applications, and aid to fishermen. — MCM

04470 **King, M. S.; Acar, K. Z.** Creep properties of Saskatchewan potash as a function of changes in temperature and stress, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 226-235, illus., table, 1970.

Creep tests have been performed on sets of identical model pillars made from Saskatchewan potash ore. The pillars were subjected to constant vertical stresses in the range 5000 to 7000 psi, at constant temperatures of 80°F and 110°F for 1000 hours. These represent depths between 3400 and 4500 feet. It was concluded that, for pillars having a width-to-height ratio of 4 or more, brittle failure of the pillars would not occur at the test temperatures and stresses, provided there were no discontinuities in the roof and floor. — *from* Authors' abstract

05040 **King, Philip B.** Tectonics and geophysics of eastern North America, [Chap.] 5 *in* The megatectonics of continents and oceans (Helgi Johnson and Bennett L. Smith, editors): New Brunswick, N. J., Rutgers Univ. Press, p. 74-112, illus., 1970.

The subsea features and land features (tectonics, isotope ages, earthquake epicenters, gravity and magnetic anomalies, crustal thickness, linear features, continental margin) of North America east of the Mississippi River, north of the Gulf of Mexico, and south of Labrador are examined in light of attempts to reconstruct a fit with continents on the opposite side of the Atlantic. There is evidence for independent growth of North America by continental accretion in the building of the Grenville belt against the Canadian Shield, the Appalachian belt against the Grenville, the post-Grenville Avalonian basement and post-Appalachian geosynclinal troughs. The incompatible feature is the abrupt break-off of the Appalachian belt at the continental shelf edge off Newfoundland. Transatlantic structural comparisons show that the reconstruction of Drake and Nafe (1967) gives the best geologic fit, but still fails to resolve many geophysical problems. — VSN

Kintzinger, Paul R. *See* Hohmann, Gerald W. 04785

Kirby, John R. *See* Zietz, Isidore. 05125

04563 **Klaus, Wilhelm.** Utilization of spores in evaporite studies, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 30-33, 1970.

Many salt rocks contain fossil plant spores in a good state of preservation and in large quantity; spore concentration in rock salt is as low as 50-2,000 g/cm^3, but in salt clay of the same unit may be 100,000 g/cm^3. Salt spores are of regional value because no local pollen rain could significantly influence uniform mixture of long distance pollen assemblages. Sodium chloride-rich units contain spores with a high degree of carbonization of the coat and in special cases the fossil nucleus of the cell is present. Spores can be used in dating of salt, in problems of reworking and resedimentation, primary deposition, correlation of borehole samples of rock salt where salt layers of different geologic ages occur in the same section, and to trace sources of underground water entering a mine. — *from* Author's abstract

05002 **Klein, G. de Vries; Middleton, G. V.** Intertidal sandbars in the Minas Basin, Bay of Fundy [abs.]: Geol. Soc. London Proc. 1970, no. 1663, p. 143-144, discussion, 1970.

04698 **Klemic, Harry.** Iron ore deposits of the United States of America, Puerto Rico, Mexico and Central America, *in* Survey of world iron ore resources, occurrence and appraisal: New York, United Nations Dept. Econ. and Social Affairs, p. 411-477, illus., tables, 1970.

In the United States, the most productive iron region is the Lake Superior; deposits in six districts and two ranges are described. Magnetite and hematite are principal ore minerals; taconite is the protore of enriched deposits. Other producing areas are: the northeastern, with magnetite as the principal ore mineral; southeastern, central-western, and western, with iron ores of every type; central-Gulf, with magnetite-hematite ores in Missouri; and residual deposits in Texas, Alaska, and Hawaii. Geologic maps showing iron deposits are given for each region. Principal iron deposits of Puerto Rico are goethite in Mayaguez Mesa, and magnetite sands. In Mexico, iron deposits of significant size occur in many places and consist of hematite, magnetite, and goethite. Several iron ore deposits are known in Central America, but none have been developed. Geologic maps showing iron deposits are included for these countries. — ESL

05046 **Klotz, John W.** Assumptions in science and paleontology, [Chap.] 2 *in* Rock strata and the Bible record (P. A. Zimmerman, editor): St. Louis, Mo., and London, England, Concordia Publishing House, p. 24-39, 1970.

Much of paleontology today is based on evolution, and evolution was based historically on the principle of uniformitarianism, to which the principle of uniformity is closely allied. Recent discoveries of living fossils indicate hazards in arguing that a form did not exist during a period in which its fossils are not found in rocks. The fossil record is a highly selected sample, not representative, and not random. Study of the fossil record tends to ignore the tremendous influence that environment may have had on an organism; paleontologists have tended to emphasize differences and minimize similarities. The natural system of classification is set up on the basis of supposed evolutionary relations and then used to prove evolution. Reconstructions from a single, or few, bone(s) are not always possible, and deductions from extrapolation should be suspect. — MCM

05041 **Knopoff, Leon.** Developments in seismology and georheology, [Chap.] 6 *in* The megatectonics of continents and oceans (Helgi Johnson and Bennett L. Smith, editors): New Brunswick, N. J., Rutgers Univ. Press, p. 113-146, illus., 1970.

It is not clear whether the crust is the result of simple differentiation of mantle material, or whether crust and mantle are polymorphic phase changes of each other; a complex inner core-outer core boundary indicates significant chemical complexity at those depths. Seismic velocities indicate that viscosity is much higher in the lower

than in the upper mantle. Because the lower mantle is highly viscous, thermal convection is unlikely. If convection is confined to the upper mantle, then that due to vertical temperature gradients cannot have great enough lateral extent to have driven continents as far apart as their present locations. Seismic discontinuities at depths of 360 and 600 km in the mantle indicate further chemical differentiation and argue against convective mass transport across boundaries. Convection appears constrained to thin layers, coupled to a highly mobile worldwide system of moving, rigid, interacting plates. — *from* Author's summary

05102 **Ko, H. Y.; Christensen, E. M.** Lunar soil erosion — Surveyor attitude control jets, *in* Analysis of Surveyor data: California Inst. Technology Jet Propulsion Lab. Tech. Rept. 32-1443, p. 141-163, illus., 1970.

During the Surveyor landings attention was directed to effects of exhaust gas impingement on the lunar surface. In the laboratory, in a vacuum environment, tests were made of pressure characteristics and effects on a soil surface of the exhaust plume of the attitude control jet. A rough soil surface was disturbed in a manner similar to that on the lunar surface. Erosion caused by the jet varied with soil properties. The 1-s firing of the jet at a 3-in. height in a completely cohesionless soil formed a bowl-shaped crater of about 3-in. diameter and one-half in. depth; a soil of 0.4 psi die not erode at all with the jet as close as one-half in. to the surface. — JHF

Koehn, Henry H. *See* Youngblood, Irma. 04795

05060 **Kohout, F. A.** Reorientation of our saline water resources thinking, *in* Saline water symposium: Water Resources Research, v. 6, no. 5, p. 1442-1448, illus., 1970.

Desalination, making sweet water from salt water, is one of the most important factors that change the direction of our investigation of the nation's water resources. Projected costs for desalting in the mid-70's are in the range of 25 to 50 cents per 1,000 gallons at the plant, which is in the same range as consumer costs for delivered water in large cities in 1969. In addition, pore space occupied by saline ground water can be a useful medium for storing natural gas, for artificial recharge, and recovery of fresh water stored as 'bubbles,' or for storing certain toxic industrial wastes. Our thinking, planning and investigative funding must be greatly expanded to provide necessary data on the physical, chemical, and hydrologic boundaries of saline water systems. On this total view of the environment depend enlightened engineering and legal decisions concerning best use of saline ground water and saline aquifers. — *from* Author's abstract

04599 **Komar, Paul D.; Inman, Douglas L.** Longshore sand transport on beaches: Jour. Geophys. Research, v. 75, no. 30, p. 5914-5927, illus., tables, 1970.

Simultaneous field measurements of wave and current parameters in the surf zone and the resulting longshore transport of sand have been made on two beaches under a variety of conditions, and used to test two models for prediction of the longshore transport rate of sand. Results confirm that the immersed weight longshore transport rate of sand is directly proportional to the longshore component of the wave energy flux arriving at the beach, as predicted by the first model. The second model whereby wave motion provides the stress to support the sand and a superimposed longshore current causes a net transport also successfully relates sand transport rate to wave and current parameters. If a component of the longshore current is generated by some mechanism other than oblique wave approach, the second model appears to be more flexible and would predict longshore sand transport, providing that the longshore current is known. — DBV

04512 **Koteff, Carl.** Surficial geologic map of the Milford quadrangle, Hillsborough County, New Hampshire: U.S. Geol. Survey Geol. Quad. Map GQ-881, scale 1:62,500, text, 1970.

Preglacial geology, glacial and postglacial deposits, glacial and postglacial history, and economic geology of the Milford quadrangle are summarized. — MCM

04810 **Kotick, Ottmar F.** Edward W. Beltz (1891-1970): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 9, p. 1753-1754, portrait, 1970.

04725 **Kravitz, Joseph H.; Sorensen, Fredrick H.** Sedimentological reconnaissance survey of Kane Basin: Maritime Sediments, v. 6, no. 1, p. 17-20, illus., 1970.

U.S. Naval Oceanographic Office personnel on a U.S. Coast Guard ship, "Southwind," conducted a sedimentological reconnaissance of Kane Basin, part of the Nares Strait, and of part of Smith Sound in order to obtain data on the composition and configuration of the floor of the basin. Preliminary results of the survey are given. Grab samples and cores contained coarse materials with little stratification. Photos of the basin showed coarse, poorly sorted, terrigenous material strewn about the floor. The primary agent of transport and deposition of the most recent sediments appears to be ice rafting. — EH

04601 **Krimmel, Robert M.** Gravimetric ice thickness determination, South Cascade Glacier, Washington: Northwest Sci. v. 44, no. 3, p. 147-153, illus., 1970.

A gravimetric analysis was made in July, 1968 of the South Cascade Glacier in the North Cascade Range of Washington. Standard Bouguer, free air and latitude corrections were added to station gravity readings. Computed terrain corrections introduced only a tolerable error. Terrain-reduced Bouguer values were corrected for a regional trend and combined with data from other surveys in the area. A map of gravity anomalies was compiled. An estimation and two reestimations of ice thickness were made until observed and calculated anomalies agreed closely. Data from one borehole was valuable and increased accuracy. A gravimetric interpretation of bedrock configuration is given. — EH

Kube, W. R. *See* Elder, J. L. 04671

04537 **Kudělásek, Vladimír; Polický, Josef; Zamarsky, Vitězslav.** A contribution to the geochemistry and petrology of the ultrabasics of Cuba: Carolina Univ. Acta, Geologica 1969, no. 2, p. 119-131, illus., tables, 1970.

The paper deals with the results of petrographic, petrologic, and geochemical studies of ultrabasic and spatially associated basic rocks of the middle and eastern parts of Cuba. The ultrabasics are represented by serpentinites formed by serpentinization of dunite harzburgites, dunite lherzolites, and a minor amount of dunite. The ultrabasics represent less differentiated or undifferentiated types derived from a peridotitic magma. The geochemical and petrologic characteristics of the ultrabasic massifs give evidence of their conformable origin; the authors believe them to be derived from a hypermagbasic type of magma. The results of the studies of the ultrabasics of Cuba, occurring in less metamorphosed areas, and some of the genetic conclusions based on these studies contribute to the solution of similar problems in areas affected by metamorphism. — *from* Authors' abstract

Kulm, L. D. *See* Fowler, Gerald A. 04897

04566 **Kunasz, Ihor A.** Significance of laminations in the Upper Silurian evaporite deposit of the Michigan Basin, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 67-77, illus., 1970.

Halite in subsurface working at Windsor, Ontario, and Detroit, Mich., occurs cyclicly interlaminated with dolomite and anhydrite, an association attributed to seasonal changes in basinal environment and to influx of normal sea water. Bromide data recorded from samples of individual layers indicate: (1) bromide content of halite overlying the laminations falls below the theoretical minimum of 75 ppm; (2) maximum bromide value does not occur at top of halite layers but at an intermediate position within each layer; and (3) bromide values in any given halite layer decrease toward basin margins. Bromide trends suggest two seasons of deposition: a dry characterized by deposition of laminations and of the lower part of halite layer in which bromide trend is positive; and a wet which resulted in deposition of upper part of halite in which bromide trend is negative. Solution and redeposition appear to

have been the main mechanism of marginal salt accumulation. — *from* Author's abstract

04737 **Kunzler, R. H.; Goodell, H. G.** The aragonite-calcite transformation — A problem in the kinetics of a solid-solid reaction: Am. Jour. Sci., v. 269, no. 4, p. 360-391, illus., tables, 1970.

A nucleation and growth process is operative during the aragonite-calcite transformation. An Avrami analysis is used to describe the reaction kinetics. Chemical impurities have less effect on the transformation than the physical conformation of the individual aragonite crystallites. Four types of inversion curves are present. A correlation exists between the geologic age of aragonite and the rate of its transformation; the older the aragonite, the slower the rate at any given temperature. An annealing process tends to stabilize individual aragonite crystallites by the coalescence of smaller domains into larger ones, thereby lowering their energy and increasing their stability. It is unlikely that natural aragonite will transform into calcite within long spans of geologic time unless it is exposed to solutions and/or elevated temperatures. — *from* Authors' abstract

04576 **Kupfer, Donald H.** Conflicting strain patterns in the salt of Gulf Coast salt domes and their genetic implications, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 271-282, illus., 1970.

Anomalies are present in the structure of the salt exposed in Gulf Coast salt mines. Drag and shear structures suggest horizontal movements during folding that contrast sharply with the known vertical movement. Attenuation of vertically-plunging folds and tubes, and model experiments confirm vertical motion. Explanations involving flexure, shear, and plastic flow supply partial answers. Preliminary mapping of the pattern of drag folds in complexly folded stocks confirm multiple stages and methods of movement, and yield promise for future differentiation of the fold structures impressed during horizontal migration in the mother bed from those impressed during much later flowage over long distances and at elevated temperature. — Author's abstract

04997 **Labounsky, Alex.** New geophysical exploration tool under development: Eng. and Mining Jour., v. 171, no. 5, p. 80-82, illus., 1970.

Differential induced polarization has been successful in pinpointing anomalies of metallic and nonmetallic origin. It is a composite of systems: the DIP unit, relating electrical characteristics of a ground area with the electrochemical equivalents of the elements present, and a system to measure and record the presence of any self-potential fields and their polarity. When information from these systems is combined with that from another, testing local magnetic deviations at each DIP station, the operator is able to interpret structures more accurately than with any one alone. A list of elements most likely to be encountered, with their electrochemical equivalent values is included, and several studies using this method are described. — ESL

04752 **Lafayette Geological Society; Spencer, Samuel A.; Harrison, Frank W., Jr.; Jones, Richard K.; Searles, Leonard C.** (chairman and editors). Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., sections paged separately, illus., 1970.

For each of the 30 fields (cited separately) of this portion of the Gulf Coast geosyncline, the location, history, structure, and production are summarized. Structure maps and/or cross sections, and type logs are presented. — MCM

04560 **Lafon, G. Michel.** Calcium complexing with carbonate ion in aqueous solutions at 25°C and 1 atmosphere: Geochim. et Cosmochim. Acta, v. 34, no. 8, p. 935-940, illus., tables, 1970.

Experimental solubilities of calcite in water originally free of CO_2 and data on the stability of calcite (Langmuir, 1968) are consistent with moderate formation of the

$CaCO_3^\circ$ ion-pair. The dissociation constant of $CaCO_3^\circ$ is estimated. — *from* Author's abstract

04978 **Landes, Kenneth K.** Petroleum geology of the United States: New York and London, Wiley-Interscience, 571 p., illus., 1970.

This book is intended to supplement standard texts in the field by using a geographic approach to determine in what places and under what conditions hydrocarbons are known to have accumulated. The United States is divided into six subdivisions: eastern, central, eastern and central gulf, Texas, Rocky Mountain, and Pacific. An index and a 37-page bibliography are appended. — MCM

Landisman, M. *See* Mitchell, B. J. 04454

04762 **Landry, Paul R.** Gillis-English Bayou Field, Calcasieu Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 10-10c, illus., 1970.

04593 **Lang, A. H.** Historical sidelights of Brenda mine and region, Pt. 1: Canadian Mining Jour., v. 91, no. 3, p. 41-43, illus., 1970.

The Brenda copper-molybdenum property near Peachland, south-central British Columbia, provides an example of several features of current mining developments, including the long, complex evolution, and the trend toward mining large, low-grade deposits. About 1900 a number of lodes were brought into production in the region, and several new lodes were discovered. In 1954 Robert Bechtel noticed the mineralization in the Brenda prospect, and reports published earlier by the Geological Survey of Canada helped to interest Noranda Mines in the property. Additional claims were staked, and diamond drilling was done, but it was 1967 before mine preparation started. Testing included soil sampling, and magnetometer, spontaneous potential, and induced polarization surveys. Geologic exploration included petrographic and alteration studies and fracture-density mapping. The minimum gross value of the deposit is about four hundred million dollars. — ESL

Langford, N. Gerald. *See* Gould, Joseph C. 04749

LaPorte, Léo F. *See* Walker, Kenneth R. 04716

Larson, E. E. *See* Kellogg, Karl. 04799

Larson, Richard R. *See* Desborough, George A. 04904

Lasky, Samuel G. *See* Blondel, Fernand. 04696

Lastrico, R. *See* Duke, C. M. 04667

05106 **Latham, Gary V.** (and others). Passive seismic experiment, *in* Apollo 12 preliminary science report: U.S. Natl. Aeronautics and Space Adm. Spec. Pub. SP-235, p. 39-53, illus., 1970.

The passive seismic experiment is designed to detect vibrations of the lunar surface for determination of internal structure, physical state, and tectonic activity of the Moon. Signals of 40 events have been identified, 30 of which are prolonged signals (classified as type L) believed to be meteoroid impacts or shallow moonquakes. No signals with characteristics like those typically recorded on Earth are detected. The seismic energy release may be far less for the Moon, or the deep interior of the Moon may be highly attenuating for seismic waves. The absence of significant activity would imply absence of tectonic processes similar to those of Earth and lower specific thermal energy in the lunar interior. — JHF

04557 **Laul, J. C.; Pelly, I.; Lipschutz, M. E.** Thallium contents of chondrites: Geochim. et Cosmochim. Acta, v. 34, no. 8, p. 909-920, illus., tables, 1970.

The thallium contents of a number of equilibrated and "primitive" stony meteorites have been determined by neutron activation analysis. The chondritic analyses confirm Tl to be strongly-depleted. Mean Tl abundances in groups C1, C2, and C3 are 96, 46, and 32 atoms per 10^9 Si atoms respectively, which lead to ratios (relative to C1) nearly the same as those predicted by a two-component model. The Tl contents of 11 unequilibrated ordinary chondrites are intermediate to those of carbonaceous and equilibrated ordinary chondrites, and decrease exponentially with increasing equilibration of the silicate phases. Comparison of the trends exhibited by Tl and other strongly-depleted, normally depleted, and undepleted elements in ordinary chondrites suggests that the unequilibrated ordinary chondrites and carbonaceous chondrites were not formed *seriatim*, but that during formation of these chondrites, these elements were affected equally. — DBV

04610 **Laurin, A. F.; Dugas, J.** Current mining exploration and development in Quebec: Canadian Mining Jour., v. 91, no. 4, p. 66-69, illus., 1970.

Results of recent mining exploration are reviewed and future expectations discussed. Mining districts in each of the five geologic provinces are described. The Superior province is the main source of copper, zinc, gold, silver, and molybdenum; five mining centers are described. The Churchill province is known for its supply of iron ore from the Labrador Trough; nickel, copper, and asbestos are also produced. Titanium, iron, industrial and construction materials, copper, nickel, and uranium occur in the Grenville province. The Appalachian folded belt produces copper and massive sulfides. Two carbonatite bodies in the St. Lawrence Lowlands show promise of zones of niobium-bearing rocks like those at Oka. — ESL

Lawson, D. C. *See* Berg, R. B. 04699

Lee, Keenan. *See* Lyon, R. J. P. 04482

04554 **Leeman, William P.** The isotopic composition of strontium in late-Cenozoic basalts from the Basin-Range province, western United States: Geochim. et Cosmochim. Acta, v. 34, no. 8, p. 857-872, illus., tables, 1970.

The Sr isotopic composition has been measured in 34 late-Cenozoic basaltic lavas from the Basin-Range province and adjacent areas. Sr-87/Sr-86 ratios mostly fall in the range of those measured in oceanic basalts. Some systematic variations are observed in going from the Basin-Range province and Colorado Plateaus to adjacent areas; basalts from the Sierra Nevada "sub-province," the Rio Grande depression, and the northern Basin-Range province generally have higher Sr-87/Sr-86 ratios. These variations seem to be due to differences in the source regions rather than to crustal contamination. A petrologic model, in which the anomalously thin Basin-Range crust is attributed to partial melting and mobilization of the lower portion of an originally thicker Precambrian crust, appears to explain the evolution of Cenozoic volcanic activity in this region. — *from* Author's abstract

05058 **Lehman, Oliver R.; Hauser, Victor L.** Playa water quality changes with time and effects on clarification: Water Resources Research, v. 6, no. 5, p. 1420-1423, tables, 1970.

An estimated 2 to 5 million acre-feet of runoff water accumulates annually in playas on the semiarid southern high plains; however, development of this large potential water source has been impeded by lack of water quality data. Most of the water is lost by evaporation, and timely utilization is essential. Therefore, a particular need exists for quality data on freshly impounded water. Water from five playas was sampled and analyzed at intervals for 24 days following runoff from a single storm. Chemical analyses showed playa waters were excellent for irrigation; however, adequate economical clarification is probably needed for such projects as direct aquifer injection. With aging, less synthetic cationic polyelectrolyte and more alum was required for water clarification. Initially low nitrate and chemical oxygen demand values decreased with time. — Authors' abstract

05055 **Leopold, Luna B.** An improved method for size distribution of stream bed gravel: Water Resources Research, v. 6, no. 5, p. 1357-1366, illus., tables, 1970.

Random sampling of surface rocks on a gravel bar is biased toward larger sizes which, because of their area, are more likely to be picked up. Weighting can eliminate this bias. Data on average weight of a single rock are used to change numbers of rocks to weights, thus yielding size frequency data in general agreement with a sieved and weighed sample. The question of what to sample depends on the use to which the data are to be put, and is not treated in detail in this paper. — Author's abstract

05020 **Lindsay, John F.** Clast fabric strength of tillite: Jour. Geology, v. 78, no. 5, p. 597-603, tables, 1970.

A stepwise regression analysis of twenty-four variables measured from beds of tillite suggests that the stength of long-axis clast fabric in tillite is largely dependent on how much the orientation inherited from the glacier is disturbed at the ice-sediment interface during deposition. Larger particles are more likely to be reoriented than are smaller ones. Consequently, when fabric studies are made, it may be more important to select clasts on the basis of size than on the basis of shape. The strongest fabrics can be expected in thicker beds and in beds with high clay content. Striae parallel to prominent edges of clasts indicate reorientation, but proportion of striated clasts does not indicate how much, because some striated clasts are picked up from underlying beds. — *from* Author's abstract

Linn, Kurt O. *See* Evans, Robert. 04578

04984 **Lipman, Peter W.** Relations between Cenozoic andesitic and rhyolitic volcanism, western interior United States: Geol. Soc. London Proc. 1969, no. 1662, p. 36-39, discussion, 1970.

The linear belt of volcanism, plutonism, and tectonism along the west coast of North America bulges eastward in the United States. Basaltic, andesitic, and silicic volcanism are abundant and closely associated in time and space. Large volumes of Cenozoic lavas predating basin-range faulting are mainly intermediate types, erupted from scattered volcanoes. Associated with these are widespread ash-flow sheets of quartz latite and rhyolite connected with formation of large caldera complexes, probably resulting from collapse due to eruption of silicic cupolas over more mafic batholiths. This igneous activity is different from the calc-alkalic suites of island arcs and much of the Pacific margin, but the two suites represent parts of a continuum of andesitic rocks rather than two groups. Concurrently with onset of extensional faulting in the Miocene, the character of volcanism shifted to bimodal assemblages of high-silica rhyolite and basalt. — ESL

04927 **Lipps, Jere H.; Valentine, James W.** The role of Foraminifera in the trophic structure of marine communities: Lethaia, v. 3, no. 3, p. 279-286, illus., 1970.

Present knowledge of the trophic position of Foraminifera is summarized for communities inhabiting a number of distinctive marine environments: muddy-bottom shelf, sandy-bottom shelf, rocky bottom, abyssal benthonic, and pelagic. Foraminifera are recorded as feeding upon bacteria, small diatoms, nannoplankton, and organic detrital particles below 50 μ in size; in turn, they are preyed upon by a variety of larger organisms ranging from highly specialized microcarnivores that feed largely on Foraminifera to generalized feeders that ingest Foraminifera along with much other material. A trophic model is constructed that may provide a basis for further paleoecologic as well as evolutionary studies. — VMJ

Lipschutz, M. E. *See* Pelly, I. Z. 04524

Lipschutz, M. E. *See* Jain, A. V. 04556

Lipschutz, M. E. *See* Laul, J. C. 04557

04828 **Lofton, Coleman L.** Possible future petroleum provinces of United States western gulf basin, Eocene and Paleocene [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1786-1787, 1970.

04711 **Logan, Alan.** A new species of *Cyrtorostra* (Bivalvia) from the Permian of the Canadian Arctic: Jour. Paleontology, v. 44, no. 5, p. 867-871, illus., table, 1970.

The bivalve *Cyrtorostra arctica* sp.nov. is described from the Lower Permian Assistance Formation and associated strata of the Canadian Arctic Islands [West Devon and Melville]. The genera *Blandfordinia* Reed and *Prooxytoma* Maslennikov are considered to be subjective synonyms of *Cyrtorostra* Branson. — Author's abstract

04857 **Lohrengel, C. Frederick.** (compiler). Second day road log from Salt Lake City to Cedar City, Utah, via U.S. Highway 89, Long Valley Junction and Utah State Road 14, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 107-123, 1970.

04861 **Lohrengel, C. Frederick.** (compiler). Sixth day road log from Cedar City to Salt Lake City, via Minersville, Milford, Delta, and Nephi, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 145-149, 1970.

04809 **Lotz, Charles W.** (compiler). Probable original minable extent of the bituminous coal seams in West Virginia: Morgantown, W.Va., West Virginia Geol. and Econ. Survey, 1 sheet, various scales, sections, text, 1970.

The map sheet contains a generalized geologic map of the Pennsylvanian and Permian systems in West Virginia; maps showing probable original minable extent of bituminous coal seams, and coal rank and fixed carbon; a bituminous coal seam column; nomenclature of minable coal seams; and inset maps indicating probable original minable extent of each of the seams. The latter show the approximate area underlain by each minable seam, each of which has sufficient thickness and purity to be considered as a resource to be used when the more valuable beds become exhausted. — MCM

04923 **Louisnathan, S. John.** The crystal structure of synthetic soda melilite, $CaNaAlSi_2O_7$ [with German abs.]: Zeitschr. Kristallographie, v. 131, nos. 4-5, p. 314-321, tables, 1970.

The crystal structure of synthetic soda melilite was refined to $R = 5.1$ percent from three dimensional diffractometer data. Soda melilite is isostructural with the other naturally-occurring melilites. Aluminum and Si atoms are ordered in the structure while Ca and Na atoms are disordered. [It is now generally accepted that soda melilite can be established as an end member, partly represented in some natural melilites.] — Author's abstract

Lovberg, R. H. *See* Berger, Jon. 04548

Luco, J. E. *See* Duke, C. M. 04667

05112 **Lunar Sample Prelim. Exam. Team.** Preliminary examination of lunar samples, *in* Apollo 12 preliminary science report: U.S. Natl. Aeronautics and Space Adm. Spec. Pub. SP-235, p. 189-216, illus., 1970.

Samples returned by the Apollo 12 astronauts fall into four groups: fine-grained, crystalline igneous rock; medium-grained, crystalline igneous rock; breccias; and fines. The majority of the large rock samples are holocrystalline, with a range of textures and mineralogical composition characteristic of igneous origin. Most of the large crystalline rocks are rounded on one surface and exhibit glass-lined pits. Fines, approximately 20 percent glass, are lighter in color than the Apollo 11 fines. Rocks show varying degrees of shock metamorphism; some breccias show evidence of multiple shock. Glassy or aphanitic pebbles are presumed evidence of melting and fragmentation. Core samples have easily recognizable stratigraphy. Chemistry of the Apollo 11 and 12 sites is clearly related. — JHF

Lundberg, John G. *See* Cavender, Ted M. 04630

04736 **Luyendyk, Bruce P.** Reply [to discussion by George Peter of "Origin of short-wavelength magnetic lineations observed near the ocean bottom" (1969)]: Jour. Geophys. Research, v. 75, no. 32, p. 6721-6722, 1970.

The original paper under discussion appeared in Jour. Geophys. Research, v. 74, no. 20, p. 4869-4881, 1969; Abs. North American Geology, March 1970. — DBV

Luyendyk, Bruce P. *See* Bada, Jeffrey L. 04992

Luyendyk, Bruce P. *See* Phillips, J. D. 04993

04482 **Lyon, R. J. P.; Lee, Keenan.** Remote sensing in exploration for mineral deposits: Econ. Geology, v. 65, no. 7, p. 785-800, illus., tables, 1970.

Remote sensing, a new term for an old practice of airborne exploration, has become a "cure-all" for the search for new mineral deposits. This paper seeks to evaluate those aspects of the technology which can be of use to the exploration geologist, and to place the various sensors in a priority listing for several types of geological targets. A point of significance to be clearly understood is that the "skin" (or pepetration) depth of most sensors is shallow. Remote sensing really offers a chance to rapidly survey large areas, in seeking the diagnostic *surface* phenomena from more deeply hidden ore deposits. — Authors' abstract

04800 **Lyons, Paul L.** Continental and oceanic geophysics, [Chap.] 7 *in* The megatectonics of continents and oceans (Helgi Johnson and Bennett L. Smith, editors): New Brunswick, N. J., Rutgers Univ. Press, p. 147-166, illus., 1970.

Large, usually coincident regional gravity and magnetic anomalies have been investigated to find whether they contribute to a study of the Conrad layer of the crust. They do provide reasonable depth estimates. The Conrad layer itself may in turn represent an ancient Algoman surface, which may be universally associated with E-W folding and faulting. These ancient lines of weaknesses, through rejuvenation, persist into the present and afford explanations, through lateral movements along faults, for observed shifts of the crust [that is, large-scale movements of the crust are confined to lateral displacements along faults]. — *from* Author's summary

04913 **Macdonald, A. S.** Structural environment of the Salmo type lead-zinc deposits, [Chap.] 5 *in* Lead-zinc deposits in the Kootenay Arc, northeastern Washington and adjacent British Columbia — Soc. Econ. Geologists, 1970 Northwest Field Conf. Guidebook: Washington Div. Mines and Geology Bull. 61, p. 55-64, illus., 1970.

A structural evolution for host rocks of Salmo-type deposits is proposed, in which Phase I and II folding are seen to be homoaxial and the product of continuous progressive deformation. Phase III structures are tentatively related to late-orogenic deformation accompanying granitic intrusion. Deformation recognized in the sulfides suggests involvement in Phase I deformation and in regional metamorphism. The relict nature of the sulfide fabric is ascribed to general recovery following regional metamorphism and/or to annealing recrystallization promoted by subsequent thermal metamorphic events. Deformation of the sulfides does not prove a syngenetic origin, but it may be implied. The association of bedded pyrite and graphite with a slightly siliceous dolomite facies is the only recognized link with an original sedimentary environment. — *from* Author's conclusions

05032 **Macintyre, I. G.; Milliman, J. D.** Physiographic features on the outer shelf and upper slope, Atlantic continental margin, southeastern United States: Geol. Soc. America Bull., v. 81, no. 9, p. 2577-2597, illus., tables, 1970.

Both erosional and constructional processes appear to have formed physiographic features near the shelf break along the southeastern United States. On the outer shelf and upper slope between Cape Hatteras and Cape Fear, ridges and well-defined troughs may be related largely to earlier Gulf Stream erosion; whereas, between Cape Fear and Cape Kennedy, ledges, small terraces, and rises at those depths appear to be Holocene features eroded into, or constructed on the pre-Holocene sedi-

ments. Well defined ridges on the outer shelf between Cape Kennedy and Palm Beach are relict oolitic ridges or "dunes" formed during Holocene transgression. [Characteristics of rock samples are given in tables and include some C-14 ages.] — HCW

MacLean, Brian. *See* King, Lewis H. 04727

MacLean, Brian. *See* King, Lewis H. 04884

04502 **Madden, T.** Geoelectric upper mantle anomalies in the United States, *in* Symposium on multidisciplinary studies of unusual regions of the upper mantle, Madrid, Spain, 1969, Proc.: Jour. Geomagnetism and Geoelectricity, v. 22, nos. 1-2, p. 91-95, illus., 1970.

Geoelectric studies have shown that a pronounced high conductivity region exists in the upper mantle of the southwestern United States. This anomaly is well correlated with other geophysical anomalies. The electrical measurements can be interpreted to give upper mantle temperatures very close to the melting point. Preliminary measurements near the California ocean-continent boundary indicate even higher conductivities exist in the mantle under the ocean. — Author's abstract

04976 **Madsen, Beth M.** Core logs of three test holes in Cenozoic lake deposits near Hector, California: U.S. Geol. Survey Bull. 1296, 43 p., illus., 1970.

Cores and cuttings from three holes drilled into upper Cenozoic lake deposits in the Mojave Desert near Hector, Calif., were relogged and examined in detail mineralogically. An evaporite section penetrated by one of the holes consists of beds of laminated and massive anhydrite rock, mudstone, claystone, calcite rock, sandstone, and colemanite rock. Colemanite ($Ca_2Ba_6O_{11}$ $5H_2O$) is the only borate mineral present except for a few blebs of howlite. A minor amount of celestite occurs throughout the core. Beds of tuff in the cored intervals have been altered to clay minerals or the zeolites clinoptilolite, analcime, erionite, and chabazite. — Author's abstract

Majima, H. *See* Oka, Y. 05006

Malan, Roger C. *See* Sterling, David A. 04591

04894 **Mann, C. John.** On randomness and determinism — Reply [to discussion by G. G. Simpson, 1970, of 'Randomness in nature,' 1970]: Geol. Soc. America Bull., v. 81, no. 10, p. 3187-3189, 1970.

For the paper under discussion *see* ibid., v. 81, no. 1, p. 95-103, 1970; Abs. North American Geology, June 1970.

04896 **Mann, C. John.** Randomness in nature — Reply [to discussion of 1970 paper by I. J. Smalley, 1970]: Geol. Soc. America Bull., v. 81, no. 10, p. 3195-3196, 1970.

For the paper under discussion *see* ibid., v. 81, no. 1, p. 95-103, 1970; Abs. North American Geology, June 1970.

Mansfield, Charles F. *See* Cowan, Darrel S. 04452

04666 **Mantel, Erwin; Bolter, Ernst; Al Shaieb, Zuhair.** Distribution of gold, silver, copper, lead and zinc in the productive Marysville stock, Montana [with German abs.]: Mineralium Deposita, v. 5, no. 2, p. 184-190, illus., 1970.

One hundred and twenty-five whole rock samples from the productive Marysville, Montana, granodiorite and the surrounding metamorphic rocks were analysed by neutron activation analysis for gold and silver, and by atomic absorption for copper, lead, and zinc. In the vicinity of known gold veins, anomalous values for gold and silver were found in both types of bedrock. Anomalies for the base metals were much less pronounced. The results indicate that systematic analysis of igneous bodies could be useful in exploration for hydrothermal ore deposits. — Authors' abstract

05084 **Marcus, Allan H.** Comparison of equilibrium size distributions for lunar craters: Jour. Geophys. Research, v. 75, no. 26, p. 4977-4984, illus., 1970.

We consider some theoretical models of crater destruction to explain not only the exponent -2 of the equilibrium distribution of crater diameters, but also the density coefficient and its regional variations. Destruction of small craters appears to be governed principally by blanketing or filling by ejecta, and the equilibrium density coefficient decreases with increasing size of the largest crater affecting the region studied. Destruction of large craters seems to depend mainly on destruction of a substantial part of the crater wall by a crater of similar or greater diameter. Only certain south polar and far-side continental regions appear to be saturated with craters. — Author's abstract

Marlow, Michael S. *See* Scholl, David W. 04540

04980 **Marshall, Thomas R., Jr.** Oil and gas regulatory practice, Prudhoe Bay Field, Alaska: Interstate Oil Compact Comm. Comm. Bull., v. 12, no. 1, p. 43-46, 1970.

Seven years ago the Arctic coast of Alaska was rejected as flat, frozen and fragile. The permafrost up to 1200 feet deep presents dramatic problems which are now circumvented by effective means of construction and oilfield operations. Discovery of Prudhoe Bay Field in 1968 shifted interest from the inland Colville syncline, and prompted steps for proper regulatory practice. Factors outlined in favor of successful reservoir management include land ownership by the State of Alaska; experience under similar conditions in the Cook Inlet offshore; gas reserves large enough to be of salvage interest, but based on well data not yet two years old. Full-scale production must await completion of transportation facilities. Exceptions were allowed in early operations, and most operators saw the merit of wide spacing, before the required public hearing for pool rules was held. — GDC

04581 **Martinez, Joseph D.** The relationship between optical orientation and shape anisotropy in detrital gypsum grains, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 331-338, illus., 1970.

Gypsum sand has been settled in the laboratory and then impregnated. The sand is dominantly medium grained and mostly subrounded and tabular. A quantitative measure of oblateness was obtained by statistically comparing diameter ratios in vertical sections with diameter ratios in horizontal sections of the impregnated sand. Petrographically, in a vertical section, the grains are length-fast. These grains should neither be predominantly length-fast nor length-slow if they are tabular parallel to (010). Thus, some physical property other than (010) cleavage must be responsible for the observed relationship. The use of a settling tube to provide preferred orientation of nonequant grains and the statistical determination of an index of oblateness has general application in the study of detrital sediments. — *from* Author's abstract

04907 **Martinez, Joseph D.** The tectonic behavior of evaporites [abs.]: Corpus Christi Geol. Soc. Bull., v. 11, no. 2, p. 4-5, 1970.

05030 **Martinez, Joseph D.; Thoms, Robert L.; Jindal, Vinod K.** Model studies of effects of closure of solution caverns in salt domes, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 308-320, illus., 1970.

The effect of closure of solution caverns in salt domes on subsidence has been examined qualitatively by the use of time dependent two-dimensional models. Changes in stress distribution and displacements as closure proceeded were also studied. For brittle failure, subsidence occurs directly over the cavern but is principally from the sides in plastic deformation. This results in major initial subsidence overlying a zone off the sides of the cavern. After all flow has ceased due to cavern closure, the effects of subsidence will be uniformly distributed at the surface. Further, the stress gradient surrounding the cavern increased with closure. Salt generally is considered to behave as plastic. — *from* Authors' abstract

Massingill, J. V. *See* Walker, J. R. 04942

04598 **Mast, R. F.** Size, development, and properties of Illinois oil fields: Illinois Geol. Survey Illinois Petroleum 93, 42 p., illus., tables, 1970.

Estimates were made of areal size in acres of pay zones in each oil field as of January 1, 1968; pay acreage under flood and status of flood acreage and remaining primary acreage were determined also. Average properties were given for each pay zone in each oil field. Data show that 48 percent of the 734,400 pay acres were developed for waterflood and that an estimated 59.2 percent of the remaining primary wells were still active. Distribution for the different properties based on percent of total reservoir pore volume are presented for each of the four major producing lithologies. — *from* Author's abstract

04926 **Mastrogiuseppe, Joy D.; Cridland, Arthur A.; Bogyo, Thomas P.** Multivariate comparison of fossil and Recent *Ginkgo* wood: Lethaia, v. 3, no. 3, p. 271-277, illus., tables, 1970.

Multivariate statistical analysis of anatomical structure of the wood of the modern *Ginkgo biloba* (the only surviving species of the genus) and of *G. beckii* Scott, Barghoorn and Prakash, 1962 from the Miocene of Vantage, Wash., revealed significant differences not apparent by general microscopic observation. On the basis of multiple discriminant analysis by computer of 10 anatomical characters, all living wood specimens were classified into a single distinct group, and all fossil specimens were classified into another distinct group when all 10 characters were included in the analysis. Three characters — number of pits per mm of tracheid length on radial wall, ray height, and tangential diameter of late wood tracheids — accounted for most of the discrimination. — *from* Authors' abstract

04829 **Mateker, Emil J., Jr.** Yesterday, today, and tomorrow in seismic exploration [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1787, 1970.

Matten, L. C. *See* Bartholomew, R. L. 04609

Mayeda, Toshiko. *See* Schwarcz, H. P. 04650

Maynard, J. Barry. *See* Bada, Jeffrey L. 04992

McAlester, A. Lee. *See* Sutton, Robert G. 04950

McAndrews, John H. *See* Norris, Geoffrey. 04703

04983 **McBirney, Alexander R.** Andesites of North and Central America: Geol. Soc. London Proc. 1969, no. 1662, p. 30-36, illus., discussion, 1970.

In the Cascade Range, composition of Quaternary andesites and differentiation trends are uniform, but degree of differentiation and proportion of rock-types vary widely. In the central part cones consist of andesite of one composition; in volcanoes at the extremities are many basalts, rhyolites, and rhyodacites in later eruptions from vents around the flanks and base. Rocks of Central America form a continuous series between basalt and rhyolite, but their divergent character becomes apparent when individual segments are examined. To the north, the area is underlain by a thick series of Paleozoic rocks, whereas in Nicaragua and Costa Rica the only crustal rocks are late Mesozoic and Tertiary. This difference is not reflected in the composition of calc-alkaline rocks crossing it. Andesites and their associated felsic differentiates may correspond to the two invariant points in the system olivine-diopside-quartz. — ESL

04542 **McBride, Earle F.** Stratigraphy and origin of Maravillas Formation (Upper Ordovician), West Texas: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 9, p. 1719-1745, illus., tables, 1970.

The Maravillas Formation was deposited in deep water on the slope and floor of the Ouachita geosyncline in West Texas. It is composed of black chert, fetid calcarenite, micrite, marlstone, shale, and limestone-pebble conglomerate in intercalated even beds, generally 3-12 in. thick. The formation is 60 to 500 feet thick. In the Marathon

basin it is divided into three members. The upper member is chiefly limestone. The middle member is chiefly chert. The lower member is mainly shale and is the Solitario Formation of Baker and the Persimmon Gap Formation of Wilson in southern and eastern margins of exposures. The preservation of organic material, including petroleum, and the absence of bioturbation features indicate sedimentation occurred in an euxinic environment. Grain size variations suggest that a major epeirogenic pulse affected the shelf northwest of the geosyncline. — HWR

McClain, W. C. *See* Empson, F. M. 04639

04484 **McDougall, David J.** Relative concentrations of lattice defects as an index of the temperature of formation of fluorite: Econ. Geology, v. 65, no. 7, p. 856-861, illus., table, 1970.

The apparent temperature of formation of fluorite can be obtained from the relative concentration of two kinds of lattice defects (probably dislocations and Frenkel imperfections), which in turn is based on changes in irradiation sensitivity, as shown by thermoluminescence. Information on samples used is insufficient to demonstrate that the method can give precise temperatures of formation, but the apparent values are the right order of size. Justification for the method can be found in the fact that theoretical considerations appear to explain both normal and anomalous cases. On the basis of preliminary information, it may be possible to extend the method to the geothermometry of calcite and quartz. — Author's abstract

04944 **McGill, George E.; Raney, Jay Alan.** Experimental study of faulting in an anisotropic, inhomogeneous dolomitic limestone: Geol. Soc. America Bull., v. 81, no. 10, p. 2949-2958, illus., 1970.

Eighty-nine tests were run on cores of laminated dolomitic limestone at confining pressures ranging from 1 to 800 bars, and with the angle between laminae and maximum principal stress varying from 0° to 90°. Faults form parallel to laminae and independently of confining pressure when the above angle is between about 13° to 51°. Compressive strength depends primarily on confining pressure and laminae orientation but also varies significantly with Young's modulus. — AG

04830 **McGowen, J. H.** Gum Hollow Delta, Nueces Bay, Texas, depositional model for fan deltas [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1787, 1970.

04497 **McIntosh, Willard L.; Morgan, Ida M.** (compilers). Geologic map index of New Mexico, 1955-1968: Washington, D.C., U.S. Geol. Survey, scale 1:1,000,000, 1970.

04513 **McKay, Edward J.; Sargent, K. A.** Geologic map of the Lathrop Wells quadrangle, Nye County, Nevada: U.S. Geol. Survey Geol. Quad. Map GQ-883, scale 1:24,000, 1970.

04619 **McLaren, D. J.** Presidential address — Time, life, and boundaries: Jour. Paleontology, v. 44, no. 5, p. 801-815, illus., 1970.

Accurate objective definitions of time-stratigraphic Stage boundaries are needed. Some boundaries involve major evolutionary changes in unrelated plant and animal groups. The International Commission on Stratigraphy recommends that boundary stratotypes be selected in sequences of continuous sedimentation without drastic changes in fossil content. The Silurian-Devonian boundary at a stratotype chosen by the Commission will be a horizon defined in faunal terms, in as complete a sequence as can be found, and containing abundant fossils of several groups. The Givetian-Frasnian boundary is not yet defined; current usage is based on cephalopod and conodonts zonation in Germany. The Frasnian-Famennian Boundary nearly corresponds to a major change in life and may represent a worldwide catastrophic extinction. — JWH

04940 **McLeod, C. R.** Some Canadian occurrences of maghemite: Canada Geol. Survey Paper 70-7, 13 p., illus., table, 1970.

Maghemite has been found in samples from the lateritic 'buckshot' ore bands of the Steep Rock Lake [Ontario] iron deposits. Partial chemical analysis of a magnetic concentrate gave 84.42 percent Fe_2O_3, 0.36 percent FeO, and 2.8 percent H_2O. The maghemite has a cell edge of 8.33 ± 0.01 A and an average Vickers microhardness of 920. Oxidation of magnetite to maghemite is relatively common but not abundant in magnetite-bearing iron ores and iron-formations from a variety of geological environments. Maghemite forms as a rim on magnetite grains, or as irregular linear or cloud-like masses within them. There is apparently some relationship between maghemite development and polarmagnetism of samples. — Author's abstract

McReynolds, J. *See* Oro, J. 05088

Medioli, Franco. *See* Gees, Rudolph A. 04611

05069 **Menzel, David W.** The role of *in situ* decomposition of organic matter on the concentration of non-conservative properties in the sea: Deep-Sea Research, v. 17, no. 4, p. 751-764, illus., tables, 1970.

The concentration of organic matter in the ocean is examined in relation to the effect of its decomposition on the distribution of associated non-conservative properties of oxygen, nitrate, and phosphate. Current evidence illustrates the seemingly random distribution of dissolved carbon on an ocean wide scale within the relatively narrow limits of ± 0.2 mg C/l below a depth of 400 m. Plots of associated indices of organic decomposition (oxygen, phosphate, and nitrate) against salinity suggest that these parameters, within unknown time scales, are quasiconservative. If modified by the activity of living organisms, their distribution can only be explained by unvarying metabolic activity at depth. — Author's abstract

05073 **Merlino, S.** Crystal structure of aenigmatite: Chem. Commun. 1970, no. 20, p. 1288-1289, illus., table, 1970.

The crystal structure of aenigmatite [Naujakasik, Greenland], related to that of sapphirine, consists of "octahedral walls" connected by $[Si_6O_{18}]$ chains and by octahedra between walls. — *from* Author's abstract

04786 **Meyerhoff, A. A.** Continental drift — Implications of paleomagnetic studies, meteorology, physical oceanography, and climatology (a reply [to discussion by R. A. Facer, 1970]): Jour. Geology, v. 78, no. 5, p. 633-634, 1970.

For discussion, *see* ibid., p. 630-633, 1970; original paper, ibid., v. 78, no. 1, p. 1-51, 1970; Abs. North American Geology, July 1970.

Meyerhoff, A. A. *See* Paine, William R. 04834

Middleton, G. V. *See* Klein, G. de Vries. 05002

04668 **Millay, M. A.; Eggert, D. A.** A *Psaronius* with whorled leaves from the Pennsylvanian of Iowa [abs.]: Am. Jour. Botany, v. 57, no. 6, pt. 2, p. 757, 1970.

04852 **Miller, Paul T.** (compiler). First day road log from Tempe to Grand Canyon, Arizona via Interstate 17, Sedona, Flagstaff, Sunset Crater, and Desert View, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 53-61, 1970.

Miller, Paul T. *See* Smith, Clay T. 04856

04862 **Miller, Paul T.** (compiler). Seventh day road log from Holbrook to Tempe, Arizona, via Painted Desert, Petrified Forest, Meteor Crater, Winslow, Payson, and Scottsdale, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 150-155, 1970.

04606 **Milligan, G. C.** Precambrian of Cape Breton Island as a prospecting area: Canadian Mining Jour., v. 91, no. 4, p. 61-63, illus., 1970.

The paper summarizes briefly the salient points so far recognized in an investigation of the George River series of Cape Breton. The major units of the stratigraphy have been established, though the structural history is still poorly understood. The series has been invaded by a group of intrusive rocks, probably all pre-Middle Cambrian, and regional metamorphism ranges from low to very high grade. Investigation of wall-rock changes in the vicinity of known sulfide occurrences shows the sulfides to be accompanied by a halo of low-grade metamorphic minerals derived from those formed during earlier metamorphism of higher grade. In some cases the halo is sufficiently large, and the minerals sufficiently characteristic, to suggest use of the halo as a guide in prospecting. — Author's abstract

Milliman, J. D. *See* Macintyre, I. G. 05032

04759 **Mills, Lee.** Cecelia Field, St. Martin Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 7-7d, illus., 1970.

04885 **Minch, John A.; Schulte, Kenneth C.; Hofman, George.** A middle Miocene age for the Rosarito Beach Formation in northwestern Baja California, Mexico: Geol. Soc. America Bull., v. 81, no. 10, p. 3149-3153, illus., table, 1970.

The discovery of new fossil localities in Baja California near La Misión has established a middle Miocene age for the Rosarito Beach Formation and a basis for the correlation of the marine and nonmarine stages of the middle Miocene. Diverse assemblages consisting of diatoms, radiolarians, foraminifers, mollusks, sharks, rays, bony fish, marine mammals, birds, and a camelid have been identified from beds within the Rosarito Beach Formation. — Authors' abstract

04712 **Mintz, Leigh W.** The Edrioblastoidea — Re-evaluation based on a new specimen of *Astrocystites* from the Middle Ordovician of Ontario: Jour. Paleontology, v. 44, no. 5, p. 872-880, illus., 1970.

A new specimen of Astrocystites ottawaensis, of the rare echinoderm class Edrioblastoidea is described from the Trentonian Hull Limestone of Kirkfield, Ontario. This specimen is much larger and, though flattened, better preserved than any other known edrioblastoid. Newly recorded details include: a group of interbasal plates that only developed later in ontogeny; apparent sutural pores; two different sets of shallow, elongate, rimmed depressions on the elevated lateral parts of the ambulacra; additional "gonopores," and the lack of separate ambulacral floor plates, the ambulacral floors instead being composed of lateral deltoid "wings." Edrioblastoid morphology is very dissimilar from that of either blastoids or edrioasteroids. The presence of sutural pores in edrioblastoids may indicate a distant relation with eocrinoids. — *from* Author's abstract

04454 **Mitchell, B. J.; Landisman, M.** Interpretation of a crustal section across Oklahoma: Geol. Soc. America Bull., v. 81, no. 9, p. 2647-2656, illus., tables, 1970.

A crustal section from the Wichita Mountains to the northeast corner of Oklahoma was derived from a variety of observations including a reversed seismic-refraction profile, reflection data, gravity measurements, and well-log information. Depth to the M-discontinuity is a constant 46 km. Discontinuities associated with major faults crossing the profiles persist downwards to 17 km and terminate within a thin low velocity zone. Layers below this depth appear to be laterally continuous. — AG

Mitchell, J. K. *See* Scott, R. F. 05110

Mixon, R. B. *See* Harris, L. D. 04508

Moberly, R., Jr. *See* Campbell, J. F. 04489

04901 **Mookherjee, Asoke; Dutta, N. K.** Evidence of incipient melting of sulfides along a dike contact, Geco mine, Manitouwadge, Ontario: Econ. Geology, v. 65, no. 6, p. 706-713, illus., 1970.

Small sulfide 'veins' projecting into a post-ore olivine diabase dike from the massive sulfide wall at the Geco mine, display: extremely fine-grained vermicular intergrowth of pyrrhotite-chalcopyrite-sphalerite in constant proportions throughout; corroded angular to sub-rounded inclusions of diabase fragments with a thin corona of pyrrhotite-quartz symplectite; similar reaction rim along the sulfide vein-diabase contact; and distinct flowage banding parallel to vein walls and swerving around micro-xenolithic inclusions. These contrast sharply with the coarse-grain, massive, porphyroblastic texture and pyrite-pyrrhotite-chalcopyrite-sphalerite assemblage of the main ore body just inches away. These features are taken to indicate incipient melting and rheomorphic injection of sulfide into already-frozen diabase. — *from* Authors' abstract

05123 **Mookherjee, Asoke.** "Metamorphic" and "metamorphosed" sulfide deposits: Econ. Geology, v. 65, no. 7, p. 886-889, table, 1970.

It is pointed out in numerous references to recent literature that information accumulated so far on the significance of spatial, temporal, and causal relations between metamorphism and sulfide ores justifies more positive conclusions than have been attempted — more specifically, the evaluation of the efficiency of metamorphism as a potential sulfide ore-genetic process. Terms are defined and generalizations substantiated by workers concerning the roles of contact, dynamic, and regional metamorphism are reviewed, and it is concluded that evidence strongly indicates that 'remobilization' of pre-existing orebodies by metamorphism is of very localized extent and is incapable of regenerating new orebodies at some distance away from the 'homeland;' however, disseminated ore materials could be 'mobilized' by metamorphic water and deposited as orebodies at distances far enough to be labelled new deposits. — VSN

05129 **Mookherjee, Asoke.** Dykes, sulphide deposits, and regional metamorphism — Criteria for determining their time relationship [with German abs.]: Mineralium Deposita, v. 5, no. 2, p. 120-144, illus., 1970.

Relation of orebodies to adjacent dikes, often obscured by their mutual interpenetration along the contact, may be further masked due to effects of intervening or subsequent regional metamorphism. The actual chronological sequence of the three episodes (viz mineralization, intrusion, and regional metamorphism) — information often crucial from stratigraphic and orogenetic viewpoints — can be deciphered only through analyses of changes in the fabric, mineralogy, and chemistry of the contact zone and through consideration of heat and mass transfer phenomena across the interface. An attempt is made to establish objective criteria for recognition of the actual sequence of events, after examining numerous [Canadian and Indian] cases representing almost all possible time-sequence combinations. — Author's abstract

04831 **Moore, Clyde H., Jr.; Allen, Stephen H.** Lower Cretaceous Edwards carbonate beach complex, Comanche County, Texas [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1787, 1970.

04461 **Moore, George W.** Sea-floor spreading at the junction between Gorda Rise and Mendocino Ridge: Geol. Soc. America Bull., v. 81, no. 9, p. 2817-2823, illus., 1970.

A Quaternary deformation pattern revealed by new sub-bottom acoustic profiles supplements previous knowledge derived chiefly from magnetic and seismic evidence on the contemporary tectonics off northern California. An inferred age for the sedimentary cover along the axis of the southern part of Gorda Rise suggests that no volcanism has occurred along that part of the rise for more than 100,000 years. Sea-floor spreading at the rise crest has been accommodated by sinking of a keystone block that forms the floor of Escanaba Trough, the median valley of the rise. Differential movement between Pacific and American tectonic plates could have caused the deformation pattern, and during this movement, the displacement offshore beyond

the northwest end of the San Andreas fault is inferred to have divided at Cape Mendocino between a fault along Mendocino Ridge and a fault segment that connects with the Blanco fault farther northwest. — Author's abstract

Moore, K. P. *See* Schell, E. M. 04519

05077 **Moore, Thomas H.** Water geochemistry, Hog Creek basin, central Texas: Baylor Geol. Studies Bull. 18, 44 p., illus., 1970.

Rocks which crop out in this study area are limestones of the Comanchean Series, Fredericksburg and Washita groups. Highest concentration of dissolved solids in the Hog Creek hydrologic system is found at Hurst Spring where high concentrations of calcium and bicarbonate are caused by the high partial pressure of carbon dioxide in the Edwards Limestone aquifer. Nitrate nitrogen from fertilizers is stored in this aquifer and released at Hurst Spring where it behaves as a cyclic element in Hog Creek. Chloride and sulfate concentrations are dependent upon length of time water is in contact with rock. Ions of phosphate and silica are cyclic; concentrations vary with life cycles of aquatic plants. Highest ion concentrate per unit volume is found during normal flow; least is found during runoff. Low flow concentration is intermediate. Solution load is in direct proportion to water volume. — *from* Author's abstract

05121 **Moorhouse, W. W.** A comparative atlas of textures of Archean and younger volcanic rocks: Geol. Assoc. Canada Spec. Paper 8, 1 p., 20 plates, 1970.

This atlas was designed as an aid to the study of Precambrian volcanic rocks and to show that textures of a wide compositional range of Archean lavas are well preserved and can be of significance where other lines of investigation are inconclusive or unproductive. The illustrations emphasize the importance of microscopic textures and their value in defining rock types. The photomicrographs are arranged in pairs to allow a comparison of comparable features in a Precambrian rock and in a more modern volcanic rock. A brief outline of the main features of each photograph is given. — EH

04801 **Morawski, F. P.; Jeffries, J. D.; Schelske, J. E.** The Griffith story, development and operation of the Griffith mine — Pt. 1, Introduction; Pt. 2, Mining, *in* Mining Symposium, 31st Ann., and AIME, Minnesota Sec., 43d Ann. Mtg., Duluth, 1970: Minneapolis, Minn., Univ. Minnesota, p. 1-3, illus., 1970.

The mine is located in the Red Lake area in northwestern Ontario. The ore is a low-grade cherty magnetite, similar to the taconites on the Mesabi Range. The area was explored first for gold, because gold has been found in low-grade iron-formations. The two ore bodies, north and south, are on the shoreline of Bruce Lake with about two-thirds of the reserves under the lake. Only the north body has been mined to date; it outcrops on the shore and extends under the lake. Mining has been done by building dikes and dewatering portions of the lake. Soft clay on the bottom within the limits of the mine dike was removed, and the dike built on glacial till. — ESL

04971 **Morey, G. B.; Green, J. C.; Ojakangas, R. W.; Sims, P. K.** Stratigraphy of the Lower Precambrian rocks in the Vermilion district, northeastern Minnesota: Minnesota Geol. Survey Rept. Inv. 14, 33 p., illus., geol. maps, 1970.

The system of stratigraphic nomenclature used previously in the western Vermilion district is replaced by a formal nomenclature. The Ely Greenstone, Soudan Iron-Formation, and Knife Lake Group are redefined and restricted. The Lake Vermilion Formation, previously considered part of the Knife Lake Group, is formally established. The Newton Lake Formation, metavolcanics, is also recognized. Hypabyssal intrusive rocks associated with all volcanic and sedimentary rocks, were emplaced over an interval of time, so the term Laurentian should no longer be applied to them. The recognition that mafic volcanism was not confined to a single period and that a major unconformity separating an effusive volcanic episode from a younger sedimentary series is lacking, raises serious doubts about regional correlations; the terms Keewatin and Coutchiching should be abandoned as time-stratigraphic units. —*from* Authors' abstract

Morgan, Ida M. *See* McIntosh, Willard L. 04497

Morgan, J. W. *See* Ehmann, W. D. 04781

04832 **Morgan, Joseph K.** Central Mississippi uplift [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1787-1788, 1970.

Morris, E. C. *See* Shoemaker, E. M. 05091

Mott, Charles J. *See* Gould, Joseph C. 04749

05066 **Moulder, E. A.** Freshwater bubbles — A possibility for using saline aquifers to store water, *in* Saline water symposium: Water Resources Research, v. 6, no. 5, p. 1528-1531, illus., table, 1970.

Saline aquifers appear to have promising storage capabilities for fresh-water supplies. Such aquifers would be a practical alternative to surface water reservoirs in areas where natural reservoir sites are scarce or where evaporation might consume a substantial part of the water stored. A single experiment in Virginia more than 20 years ago shows that a substantial amount of fresh-water injected into the saline aquifer can be recovered. Environmental factors that affect water recovery are dispersion and mixing at the fresh-saline water interface, reshaping of the interface because of density differences of the fluids, and ground-water movement in the saline aquifer system. Investigators have shown mathematical approaches to estimating the first two factors. Available data indicate that the third factor may be significant. Feasibility studies of storage facilities should include evaluation of at least these three factors. — Author's abstract

04654 **Mueller, G.** Indications of high-temperature processes in organic geochemistry, *in* Advances in organic geochemistry — Internat. Cong., 3d, Proc. (G. D. Hobson and G. C. Speers, editors): London and New York, Pergamon Press (Internat. Ser. Mons. Earth Sci., V. 32), p. 443-467, illus., tables, 1970.

The sensitivity of a carbonaceous complex through the temperature range of 50°-800° C and its continuous, irreversible loss of volatiles with increase of temperature or decrease of pressure are most useful as a geologic indicator or in study of thermal gradients. Moreover, more than one property of the complex can be proved to change with physical conditions which makes it possible to estimate maximum temperature and pressure within a given geologic setting. This is illustrated with results from a detailed study of the North Derbyshire ore field, England, in which bitumens are associated with hydrothermal veins or basaltic intrusions. Results indicate that since organic chemical changes can occur at considerably lower ranges of temperatures than can changes in inorganic sediments, there must be numerous 'organically metamorphosed' areas within the crust. Possibly oil fields within sapropelic sediments could be explained thus. — VSN

04640 **Mullineaux, Donal R.** Geology of the Renton, Auburn, and Black Diamond quadrangles, King County, Washington: U.S. Geol. Survey Prof. Paper 672, 92 p., illus., tables, 1970.

The Renton, Auburn, and Black Diamond quadrangles, in Puget Sound lowland adjacent to and southeast of Seattle, are mostly covered by Quaternary deposits, but lower Tertiary arkosic and andesitic sedimentary rocks, intrusive andesite, and upper Tertiary sand and clay crop out locally. Pleistocene deposits consist of drift sheets of at least four major glaciations; continental ice repeatedly moved southward over the lowland and built a broad drift plain of low relief, which is now trenched by glacial troughs and river valleys. The drift plain covers more than 75 percent of the area; most of the remainder is underlain by thick, wide alluvial deposits along three major rivers. The effect of the geology on land use and the engineering properties of geologic units are described because these quadrangles will become increasingly urbanized as the Seattle metropolitan area grows. — DRM

Myers, B. N. *See* Kelly, T. E. 04921

04730 **Myerson, Robert J.** Long-term evidence for the association of earthquakes with the excitation of the Chandler wobble: Jour. Geophys. Research, v. 75, no. 32, p. 6612-6617, illus., 1970.

A means for comparing yearly earthquake counts with the ILS-IPMS polar data is devised. The comparison supports the theory of Mansinha and Smylie [1967] that earthquakes are associated with the free (Chandler) wobble of the Earth's pole. There is some indication, however, that earthquakes themselves are not the source of the wobble excitation, but are instead a parallel effect. — Author's abstract

04587 **Nace, Raymond L.** Hydrological and related data programs in the United States of America, *in* CENTO seminar on evaluation of water resources with scarce data, Tehran, Iran, 1969: Beirut, Lebanon, Middle East Devel. Div., Ministry Overseas Devel., p. 87-101, table, 1970.

Current status of Federal programs for collection of hydrological and related basic data is summarized, with emphasis on programs of the Geological Survey, Weather Bureau, and agencies of the Department of Agriculture; numbers of stations in collection networks are tabulated by parameter and duration of record. Methods are discussed, with emphasis on automatic data processing and remote sensing. During many years of water-development, the overriding objective was economic benefit; more attention is now being given to environmental factors. The science of hydrogeology is now sufficiently advanced that much development planning can be based on general hydrological knowledge in areas of the world where basic data are inadequate. The goal of new programs should not be merely to add to the bulk of data or to increase the density of networks, but to increase the effectiveness of data collected. — VMJ

Nadkarni, R. A. *See* Ehmann, W. D. 04781

Nagata, Takeshi. *See* Shima, Makoto. 05115

05029 **Nair, K.; Deere, D. U.** Creep behavior of salt in triaxial extension tests, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 208-215, illus., 1970.

It has been established from field observations and laboratory work that the time dependent response of salt is a most significant aspect of its behavior under load. This paper presents and discusses the results obtained from creep tests on salt. In order to place the subsequent discussion in proper perspective, some of the concepts involved in the selection of the mathematical representation are reviewed. — *from* Authors' abstract

04960 **National Research Council.** (Comm. Alaska Earthquake, Div. Earth Sci.). The great Alaska earthquake of 1964 — Human ecology: Washington, D. C., Natl. Acad. Sci., 510 p., illus., tables, 1970.

This volume contains numerous papers dealing with various human actions and reactions to the great earthquake in 1964; some of the activities are geological in nature, and these are cited separately by author. Emphasis is on the tsunami resulting from the earthquake and the geological evaluation of land for future use. — HRC

04953 **Natl. Assoc. Geology Teachers; Smith, Clay T.** (editor). Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region, 1970 — NAGT, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, 183 p., illus., table, 1970.

This seven-day field conference guidebook includes six papers and 14 road logs, which are cited separately, and a supplementary log for the Salina Canyon, Utah, trip. The field conference was held primarily for secondary teachers of earth sciences and other sciences. — ESL

04883 **Naugler, Frederic P.; Rea, David K.** Abyssal hills and sea-floor spreading in the central North Pacific: Geol. Soc. America Bull., v. 81, no. 10, p. 3123-3127, illus., 1970.

Abyssal hill topography in the central North Pacific between Hawaii and the Aleutian Trench possesses a strong linear character that reflects the original grain imparted to the crust during its generation. A topographic grain related to sea-floor spreading is also present in the magnetic quiet zone north of the Hawaiian Ridge where the crust may be of Early Cretaceous age. — AG

Neeley, V. I. *See* Brenden, B. B. 04782

Nelson, Arthur E. *See* Hadley, Jarvis B. 04691

05056 **Neuman, Shlomo P.; Witherspoon, Paul A.** Variational principles for confined and unconfined flow of ground water: Water Resources Research, v. 6, no. 5, p. 1376-1382, illus., 1970.

Finite element techniques are being employed to an increasing degree in solving complicated ground-water flow problems, including problems with a free surface. These methods usually rely on the development of appropriate variational principles. This paper presents several such principles for both confined and unconfined flow. — Authors' abstract

04943 **Neumann, A. Conrad; Ball, Mahlon M.** Submersible observations in the Straits of Florida — Geology and bottom currents: Geol. Soc. America Bull., v. 81, no. 10, p. 2861-2873, illus., table, 1970.

The submarine slopes that border the Straits of Florida between Miami and Bimini were traversed by the submersible *Aluminaut*. The Bimini escarpment is swept by northerly currents of 50 cm/sec or more between depths of 538 and 222 m, and 50 to 150 cm/sec between depths of 76 and 30 m. In the lower zone a sloping smooth rock surface is veneered with ripple-marked sand; in the upper zone a steep, vertical, to overhanging cliff with large talus blocks at its base is exposed. Between these two zones current velocities were 5 to 10 cm/sec, and the bottom covered with muddy sediment exhibiting tracks, burrows, and mounds. On the west side, adjacent to the seaward facing escarpment is an elongate trough 825 m deep, with ridges and mounds of muddy sand and living corals. The escarpment shows outcrops of dark phosphatic limestone from depth of 719 to 457 m. A number of current measurements indicate that the flow is persistently southward at 2 to 50 cm/sec, and opposite to the Florida Current above. This is confirmed by the orientation of bottom features. An extensive sedimentary anticline in the west-central sector of the Straits may have been built by this bottom counter current. — *from* Authors' abstract

04501 **Niblett, E. R.; Whitham, K.** Multi-disciplinary studies of geomagnetic variation anomalies in the Canadian Arctic, *in* Symposium on multidisciplinary studies of unusual regions of the upper mantle, Madrid, Spain, 1969, Proc.: Jour. Geomagnetism and Geoelectricity, v. 22, nos. 1-2, p. 99-111, illus., 1970.

Work on magnetic variation anomalies in Canada is reviewed. On Ellesmere Island, anomalous effects appear confined to a narrow zone nearly 500 km long between Alert on the north coast and Eureka on the west. The anomaly has been explained by postulating a long narrow conducting body in the lower part of the crust; such a conductor would provide a natural channel for current induced over a much broader area and also may imply an abrupt upheaval of isotherms under Ellesmere Island. Evidence supporting a thermal explanation for the anomaly is not convincing. Mould Bay anomaly extends over large parts of Prince Patrick and Melville Islands where shorter period fluctuations in the vertical component are very strongly attenuated. A massive conducting layer deep in the crust is postulated. — *from* Authors' abstract

04990 **Nichiporuk, Walter; Bingham, Elizabeth.** Vanadium and copper in chondrites: Meteoritics, v. 5, no. 3, p. 115-130, illus., tables, 1970.

Emission spectrographic analyses for vanadium and copper in sixty-seven chondritic meteorites including members from ordinary, carbonaceous, and enstatite chondrite groups give a total range of 41-84 ppm vanadium and a total range of 77-180 ppm copper. The respective average values are 61 ± 7 ppm and 115 ± 12 ppm. Detailed patterns of vanadium and copper distributions between different chondrite groups are discussed in light of recent mechanisms for chemical fractionations in meteorites. — Authors' abstract

04870 **Nichol, Ian; Garrett, R. G.; Webb, J. S.** The role of some statistical and mathematical methods in the interpretation of regional geochemical data — A reply [to 1969 discussion by A. J. Parsley and J. D. H. Doveton of 1969 paper]: Econ. Geology, v. 65, no. 5, p. 593-594, 1970.

The paper under discussion by Parsley and Doveton (ibid., v. 64, no. 7, p. 830; Abs. North American Geology, April 1970) was originally published in Econ. Geology, v. 64, no. 2, p. 204-220, 1969; *see* Abstracts of North American Geology, December 1969. — VSN

05033 **Noble, Donald C.** Loss of sodium from crystallized comendite welded tuffs of the Miocene Grouse Canyon Member of the Belted Range Tuff, Nevada: Geol. Soc. America Bull., v. 81, no. 9, p. 2677-2687, illus., tables, 1970.

The Grouse Canyon Member of the Belted Range Tuff is an extensive comenditic ash-flow sheet. Most rocks of the unit are densely welded and exhibit primary groundmass crystalllization. Aphyric nonhydrated glassy tuff from the basal glassy zone contains 5.35 to 5.40 weight percent Na_2O. Aphyric to phenocryst-poor granophyrically crystallized and devitrified tuff from the lower part of the sheet, which otherwise is chemically similar to the glassy tuff, contains 4.1 to 5.1, median 4.75, weight percent Na_2O. The crystallized tuff undoubtedly lost sodium during or shortly after crystallization and cooling. The loss is a direct result of the peralkaline character of the parent melt: not enough Al and Fe was available to combine with all the Na, K, and Ca present in the glass to form feldspar, pyroxene, and amphibole. Similar loss of sodium appears to be a general feature of final crystallization stages in most peralkaline silicic melts. — *from* Author's abstract

Nooner, D. W. *See* Gelpi, E. 04602

04979 **Norling, Donald L.** Ohio — 110 years of oil and gas: Interstate Oil Compact Comm. Comm. Bull., v. 12, no. 1, p. 47-63, illus., tables, 1970.

Soon after the drilling of Pennsylvania's Drake well in 1859, Ohio became an oil producing state, although Hildreth (1838) recorded oil shows in brine wells drilled in 1814 and 1822. Highlights in development are presented by two 20-yr and two 30-yr periods and the last decade, during which the drilling of between 180,000 and 200,000 wells resulted in cumulative recovery of over 758.8 million bbls of oil and 3.5 trillion cu ft of natural gas. In review of geologic background, a Paleozoic column gives presently accepted principal members and drillers' names for some units; many nomenclature changes were made through the years. About 100 wells penetrated into the Precambrian, the deepest in Nobel County at 11,442 feet. In a summarizing graph, a large peak from 1886 to 1910 reflects production from the Trenton dolomite with a maximum 23,941,169 bbls in 1896, and that from 1963 to 1966, Cambrian production from Morrow County, with a maximum 15,850,000 bbls in 1964. — GDC

04703 **Norris, Geoffrey; McAndrews, John H.** Dinoflagellate cysts from postglacial lake muds, Minnesota (U.S.A.): Rev. Palaeobotany and Palynology, v. 10, no. 2, p. 131-156, illus., table, 1970.

Cysts from latest postglacial muds from Glatsch Lake are not recycled and were probably produced by motile dinoflagellates living in the lake. Four cyst types are described which are characterized by unique archeopyle types and which probably have affinities with *Peridinium*. Separate systems of classification and nomenclature for cysts and thecae are advocated. Arrested cyst stages are recognized, described,

and compared with similarly-appearing, fully-developed cysts of another type. Maximum abundance was about 300 years B.P. All three cyst types resemble in gross structure many Mesozoic and Cenozoic dinoflagellates usually interpreted as marine. The archeopyle may prove to be a feature on which more refined paleoecologic interpretations can be based. — HRC

Norton, Elinor. *See* Fireman, E. L. 04555

04963 **Norton, Frank R. B.; Haas, J. Eugene.** The cities and towns, *in* The great Alaska earthquake of 1964 — Human ecology: Washington, D. C., Natl. Acad. Sci., p. 248-356, illus., 1970.

This portion of the volume contains descriptions of the effects of the 1964 earthquake on the larger communities in southern Alaska, primarily Anchorage, Seward, and Kodiak. Descriptions of landslides and tsunamis are included. The work is primarily devoted to human organizational response to the disaster, however. — HRC

04964 **Norton, Frank R. B.; Haas, J. Eugene.** The native villages, *in* The great Alaska earthquake of 1964 — Human ecology: Washington, D. C., Natl. Acad. Sci., p. 357-399, illus., 1970.

Descriptions, in narrative form, of the tsunamis which overran several Eskimo villages in Prince William Sound, are included in this account of the human response to the disaster from the sea. — HRC

04811 **Norton, George H.** Gilbert Parvin Moore (1898-1970): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 9, p. 1754-1755, portrait, 1970.

Nowroozi, Ali. *See* Seeber, Leonard. 04687

Nutalaya, Prinya. *See* Braddock, William A. 04507

04748 **Oakeshott, Gordon B.** (compiler). A guide to information on the geology of California: California Div. Mines and Geology Mineral Inf. Service, v. 23, no. 10, p. 195-199, illus., 1970.

The principal sources of information on the geology of California are the California Division of Mines and Geology and the U.S. Geological Survey. A selection of the former publications is listed with information on prices and order procedure. Indexes to geologic and gravity map sheets are included. — MCM

Offield, T. W. *See* Pohn, H. A. 05086

05087 **Offield, T. W.; Pohn, H. A.** Lunar crater morphology and relative-age determination of lunar geologic units — Pt. 2, Applications, *in* Geological Survey research 1970, Chap. C.: U.S. Geol. Survey Prof. Paper 700-C, p. C163-C169, illus., table, 1970.

Lunar craters larger than 8 km have been assigned inferred ages expressed as decimals — 0.0 (oldest) to 7.0 (youngest) — on the basis of a detailed succession of morphologic differences attributed to aging processes. Relative ages of lunar basins and regional geologic units can be determined by dating the oldest craters superposed on them, and moonwide age sequences and correlations are thus made possible. Such age determinations indicate that mare basins formed in the following order: Nectaris, Serenitatis, Humorum, Crisium, Imbrium, and Orientale. Mare surface units were emplaced in the following generalized order: Fecunditatis, Tranquillitatis, Imbrium, Crisium, Humorum, eastern Procellarum, western Procellarum. Regional light plains units are dated as the same age as some dark mare units; albedos and crater abundances are not valid age criteria for these units. A further application is the identification of basin ejecta blankets and possible basin secondary craters. — Authors abstract

04779 **Ogden, Park.** Ville Platte Field, Evangeline Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 29-29c, illus., 1970.

04558 **Ogner, Gunnar; Schnitzer, Morris.** The occurrence of alkanes in fulvic acid, a soil humic fraction: Geochim. et Cosmochim. Acta, v. 34, no. 8, p. 921-928, illus., table, 1970.

This paper reports the isolation of alkanes from water-soluble soil fulvic acid (FA). The distribution of normal alkanes was examined in considerable detail in order to obtain information on their qualitative and quantitative composition, nature of their association with the FA, and their origin. The fact that alkanes and long-chain fatty acids become solubilized in water when occurring in the FA suggests that FA may act as a vehicle for mobilization, transport, and immobilization of high molecular weight organic molecules — many of which may be serious pollutants — in an aquatic environment. — DBV

04910 **Ohle, Ernest L.** Mississippi Valley type ore deposits, a general review, [Chap.] 2 *in* Lead-zinc deposits in the Kootenay Arc, northeastern Washington and adjacent British Columbia — Soc. Econ. Geologists, 1970 Northwest Field Conf. Guidebook: Washington Div. Mines and Geology Bull. 61, p. 5-15, illus., 1970.

Ore deposits of the Mississippi Valley type are important sources of lead, zinc, barite, and fluorspar, as well as significant sources of several other metals. Each area has individual characteristics in mineralogy and structural environment, but all of them have certain similarities which suggest that they have a common origin. Each of the various hypotheses of origin, however, has certain objections, and it may be some time before diagnostic evidence is found which supports a hypothesis that gains universal acceptance. Nonetheless, much has been learned both in the field and in the laboratory over the past 20 years and there is hope. Meanwhile, exploration continues to find important new ore areas and it is evident that these deposits will continue to be valuable sources of lead, zinc, barite, fluorspar, and the other commodities for many years to come. — Author's summary

Ojakangas, R. W. *See* Morey, G. B. 04971

05006 **Oka, Y.; Majima, H.** A theory of size reduction involving fracture mechanics [with French abs.]: Canadian Metall. Quart., v. 9, no. 2, p. 429-439, illus., 1970.

To derive an energy equation for the size reduction process, stress and deformation experienced by an irregularly shaped rock particle, subjected to a pair of concentrated loads directed in compression at the shortest distance, were analyzed by the theory of elasticity. The strain energy required for size reduction was found to be proportional to the third power of particle size and the square of tensile strength, as well as inversely proportional to Young's modulus. Considering the size effect on tensile strength, this energy is found to be proportional to the $3[1-(2/\beta)]$th order of particle size (β = the coefficient of uniformity of rock), an equation which fits other theories. This theory permits an accurate energy calculation for a selected size reduction operation from laboratory test information on rock specimens, such as tensile strength and Young's modulus. — *from* Authors' abstract

Okada, Akihiko. *See* Shima, Makoto. 05115

05082 **O'Keefe, John A.** Apollo 11 — Implications for the early history of the solar system: EOS, v. 51, no. 9, p. 633-636, 1970.

An attempt is made to show that the Apollo 11 data support the idea that the Moon was formed by the breakup of the Earth and that after the breakup, the Moon went through a heating episode that boiled away most of its mass. It is further suggested that the planets might have been formed in a similar way — that is, by breakdown of Jupiter-sized objects rather than by buildup from smaller ones. Evidence for these theories is taken primarily from chemical composition measurements. The difficulties involved in getting the process of condensation of small bodies started and the problems involved with this theory are discussed. — GV

04833 **Oliver, William B.** Depositional systems in Woodbine Formation (Upper Cretaceous), northeast Texas [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1788, 1970.

04797 **Olsson, Richard K.** Biostratigraphy, magnetic stratigraphy, and sea floor spreading, [Chap.] 11 *in* The megatectonics of continents and oceans (Helgi Johnson and Bennett L. Smith, editors): New Brunswick, N. J., Rutgers Univ. Press, p. 241-252, illus., 1970.

The proof of sea-floor spreading lies in documenting an age relation among the igneous basement, the magnetic anomaly, and the overlying sediment. Biostratigraphy of fossil plankton not only has provided much data supporting spreading, but major advances in biostratigraphy have developed as a result of intensive study of geomagnetics and paleontology. The literature is reviewed to show that a basic framework of ages of reasonable accuracy is now available to which biostratigraphic and geomagnetic data from continuing deep-sea sediment sampling can be related. A modification of Berggren's (1969) geomagnetic scale and time scale of the last 70 m.y. showing diagnostic foraminiferal evolutionary and extinction datum planes is reproduced. — VSN

Onuki, H. *See* Ernst, W. G. 05079

Oró, J. *See* Gelpi, E. 04602

Oró, J. *See* Gelpi, E. 04603

Oró, J. *See* Gelpi, E. 04604

05088 **Oró, J.; Gilbert, J.; Updegrove, W. S.; McReynolds, J.; Ibanez, J.; Gil-Av, E.; Flory, D.; Zlatkis, A.** Gas chromatographic and mass spectrometric methods applied to the analysis of lunar samples from the Sea of Tranquillity: Jour. Chromatographic Sci., v. 8, no. 6, p. 297-308, illus., tables, 1970.

Analytical methods applied, measurements made, and data obtained on organic and organogenic matter in lunar samples from Apollo 11 are discussed and summarized in a table. H_2, CO, CO_2, N_2, H_2S, CH_4, and traces of hydrocarbons have evolved by action of heat or acids on fine particulate material from the Moon. It is proposed that if these gases, together with other compounds such as water and calcium phosphate, were present on a body of the solar system (for example, primitive Earth) gravitationally capable of retaining an atmosphere and hydrosphere of this composition, the synthesis of organic molecules of biologic significance would have been inevitable. Whether they are present on the Moon can be answered only by continued study of samples from diverse locations. — *from* Authors' summary

Ostenso, N. A. *See* Wold, R. J. 05010

Ostrom, D. *See* Duke, C. M. 04667

04793 **Ostrom, John H.** Archaeopteryx — Notice of a "new" specimen: Science, v. 170, no. 3957, p. 537-538, illus., 1970.

A fourth specimen of *Archaeopteryx* (cf. *lithographica*), the oldest known, fossil bird, was recently found in the collections of the Teyler Museum in the Netherlands. Unique preservation of the horny sheaths of the manus claws provides new evidence that may be relevant to the question of the origins of avian flight. Tentative interpretation suggests a cursorial rather than arboreal origin. — Author's abstract

04510 **Outerbridge, William F.** Geologic map of the Sherbourne quadrangle, northeastern Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-854, scale 1:24,000, text, 1970.

Limestone, the chief mineral resource in the Sherburne quadrangle, has been quarried from the Great Lake Limestone, and the Fairview and Clays Ferry Formations. Most of the formations, except the Kope, stand well in steep-walled cuts and have stable slopes. — MCM

04462 **Page, Benjamin M.** Time of completion of underthrusting of Franciscan beneath Great Valley rocks west of Salinian block, California: Geol. Soc. America Bull., v. 81, no. 9, p. 2825-2833, illus., 1970.

Underthrusting of Franciscan rocks beneath Great Valley rocks seems to have been completed by the end of the Oligocene in the region west of the Salinian block. Both Franciscan and Great Valley assemblages are latest Jurassic-Cretaceous in age. Clasts derived from both first appear together in the Vaqueros Formation (Upper Oligocene,-Lower Miocene) which locally rests on both assemblages and extends across a fault separating the two. If underthrusting ceased before the end of the Oligocene, the timing is compatible with the termination of NE-SW relative motion at the continental margin, and the beginning of NW-SE relation motion when North America met the Main Pacific plate. Much or all activity on the San Andreas fault followed this event. — *from* Author's abstract

04881 **Page, Robert.** Dating episodes of faulting from tree rings — Effects of the 1958 rupture of the Fairweather fault on tree growth: Geol. Soc. America Bull., v. 81, no. 10, p. 3085-3094, illus., tables, 1970.

Surface faulting associated with major earthquakes commonly kills, damages, or otherwise disturbs the growth of trees along the fault trace. Because severe disturbances are reflected in the annual growth, tree-ring sequences provide a basis for dating recent episodes of faulting. The validity of this method is confirmed by data collected from the Fairweather fault zone in southeastern Alaska. Marked changes in growth that correlate with large-scale faulting in 1958 resulted from tilting, felling, and topping of trees and changes in ground-water level and exposure to sunlight. — Author's abstract

04760 **Paine, William.** East Basile Field, Evangeline Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 8-8c, illus., 1970.

04773 **Paine, William.** Neale Field, Beauregard Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 21-21c, illus., 1970.

04756 **Paine, William R.** Bear-Ragley Fields, Beauregard Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 4-4c, illus., 1970.

04834 **Paine, William R.; Meyerhoff, A. A.** Gulf of Mexico basin — Interactions among tectonics, sedimentation, and hydrocarbon accumulation [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1788-1789, 1970.

05074 **Paist, Donald A.; Pings, W. B.** Vanadium — 1970: Colorado School Mines Mineral Industries Bull., v. 13, no. 4, 24 p., illus., tables, 1970.

The physical and chemical properties and occurrence of vanadium are reviewed. It occurs in all valence states from +5 to -1. There are 65 known minerals described in a table, but only five are original and primary: patronite, bravoite, sulvanite, davidite, and roscoelite. Ore deposits described include: sandstone, bituminous sediments, vanadiferous clays, titaniferous magnetite, vanadates, and phosphates. Subjects discussed also include: the extractive metallurgy, vanadium products, and production and reserves. — ESL

Pajari, G. E., Jr. *See* Ghosh-Dastidar, P. 04487

04584 **Pamenter, Bev.** Gaspé region beckons oil hunters: Oilweek, v. 21, no. 33, p. 18, 20, illus., 1970.

Structural and stratigraphic traps are drawing many large oil companies to the Gaspé Peninsula and related islands. Main targets are Ordovician-Silurian carbonates, but sands terminated by thrusting or subcropping could be important. A well being drilled on the south shore of Anticosti Island is aiming for the dolomites of the Or-

dovician Romaine Formation around 12,000 feet. Faulting is common and may provide traps. Six dry holes were drilled on the north shore between 1963 and 1966. A well being drilled on Brion Island in the Gulf of St. Lawrence will probably test the same formation. Along the south shore of the St. Lawrence River, structures similar to the Alberta foothills are being explored. Thrusted carbonate sheets, 2,000-4,000 feet thick are the main targets. — ESL

04472 **Panek, Louis A.** Methods and equipment for measuring subsidence, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 321-338, illus., 1970.

This report describes measurement techniques and equipment that are appropriate for determining the horizontal and vertical components of displacement and strain, tilt, and curvature. Particular attention is given to the principal characteristics and uses of monuments, extensometers, tapes, electronic distance-measuring instruments, theodolite, alignment telescope, spirit level, tilt meter, and borehole inclinometer probe. Choice of an appropriate combination of elements with which to carry out a subsidence study depends on the type of information sought, the precision required, the funds available, and the manpower. — *from* Author's abstract

04768 **Parker, Phillip D.** Lake Arthur Field, Jefferson Davis Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 16-16c, illus., 1970.

Parkin, C. W. *See* Dyal, P. 05107

05078 **Parsley, Ronald L.** Revision of the North American Pleurocystitidae (Rhombifera-Cystoidea): Bulls. Am. Paleontology, v. 58, no. 260, p. 135-213, illus., 1970.

The rhombiferan pleurocystitids of North America, Middle and Upper Ordovician in age, have three or one pectinirhomb(s), or the pectinirhombs may be lost altogether. The taxobases of this family have been reexamined, and some new plate terminology (modifying Regnell's and Paul's) in the distal end of the theca has been introduced. Most of the extant type material has been photographically illustrated, some of it for the first time. All of the described species are redescribed or placed in synonomy. North American genera and species recognized are: *Pleurocystites squamosus*, *P. filitextus*, *P. watkinsi*, *P. beckeri*, *P. anticostiensis*, *P. distans; Coopericystis pyriformis*, n.gen., n.sp.; and *Amecystis laevis*, *A. raymondi*, n.sp. Some evolutionary trends are: reduction in the number of pectinirhombs; concomitant with this reduction, more regular outlines assumed by the plates on the rhomb surface; and increased number and decreased size of the periproctials. — *from* Author's abstract

04917 **Pastoor, D. W.** Geology of the Invincible tungsten ore zone of Canadian Exploration Limited, Salmo, British Columbia, [Chap.] 9 *in* Lead-zinc deposits in the Kootenay Arc, northeastern Washington and adjacent British Columbia — Soc. Econ. Geologists, 1970 Northwest Field Conf. Guidebook: Washington Div. Mines and Geology Bull. 61, p. 99-106, illus., 1970.

This brief description of the Invincible tungsten mine is included because of its proximity to the Jersey lead-zinc deposits, and its possible genetic relations to them. The mine has been active off and on since 1941, sometimes producing lead and zinc as well as tungsten. The present mine is not in production yet, but 278,000 tons grading 0.78 percent tungstic oxide have been outlined by over 34,000 feet of diamond drilling. The ore zone is divided by a 650-foot-long area of granite cross dikes. Tungsten ore occurs where limestone is in contact with Dodger granite, and is localized by fractures, faults, and brecciation. — ESL

05094 **Patterson, James H.; Turkevich, Anthony L.; Franzgrote, Ernest J.** Chemical analysis of the lunar surface in the Surveyor program — Summary, *in* Symposium on planetary atmospheres and surfaces, Woods Hole, Mass., 1969: Radio Sci., v. 5, no. 2, p. 181-183, 1970.

Chemical analyses of lunar surface materials were obtained in situ by Surveyors 5, 6, and 7, by a method utilizing two interactions of alpha particles with matter. The samples were found to be similar in composition to basalt, but without the composition of supposed primordial solar system materials or common types of meteorites. — JHF

04577 **Paulson, Oscar L., Jr.** Wrench faulting as a trigger mechanism for interior salt ridges of Mississippi, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 283-285, illus., 1970.

In attempting to apply various theories which have been proposed for growth of salt domes and ridges in the Gulf Coast Province, it has been possible to eliminate some of the theories which are incompatible with observed data. Recent evidence indicates that the movement of salt in a number of ridges began when overburden was a few hundred feet thick rather than the thousands of feet proposed in several earlier studies. Initial movement of the salt has been attributed to a number of factors but it now seems most probable that this movement was triggered by the presence of preexisting wrench faults along which deep-seated salt ridges were formed. The wrench faults appear to be related to late Paleozoic displacement of the Ouachita thrust sheet which arches into Mississippi where it becomes the principal wrench fault. — Author's abstract

04783 **Payne, J. N.** Geohydrologic significance of lithofacies of the Cockfield Formation of Louisiana and Mississippi and of the Yegua Formation of Texas: U.S. Geol. Survey Prof. Paper 569-B, p. B1-B14, illus., table, 1970.

Thickening and thinning of formations of the Eocene Claiborne Group, reflect structural movement during deposition. In Texas, maximum 1,700-ft thickness north of Houston and 1,500 feet in Duval and Webb Counties, suggest predominantly longshore and nearshore environments. More easterly, deltaic-fluvial plain deposition is indicated, and greater areas of interlacing channel paths are thought to record ancestral Mississippi and Trinity Rivers. With recharge increased by leakage from the Sparta Sand, fresh water in the Cockfield is extended downdip on the east side of the Mississippi alluvial valley, which controls regional flow of ground water in both formations; discharge is primarily by leakage through overlying beds, toward the gulf coast geosyncline. Water quality reflects lithologies and piezometric surfaces, and bicarbonate, chloride, and sulfate types are present.— GDC

Pearce, F. *See* Gold, T. 05111

04469 **Pegler, A. V.** The aeolotropy of thermal conductivity in rock, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 216-225, illus., tables, 1970.

This paper is primarily concerned with studying the differential directional components of heat flow in naturally occurring rock formations, and to consider directional heat flow effects of induced temperature increases of surface and underground origin. A preliminary feasibility study indicated the possibility that the thermal conductivity from an induced source is not an isotropic property of rock. Further investigation of available literature has not indicated that the research has been conducted into this subject using internal point heat sources. Present research just being commenced is at the stage of developing an instrumentation and measurement system. — *from* Author's abstract

Pelletier, B. R. *See* Brooke, J. 04549

Pelly, I. *See* Laul, J. C. 04557

04524 **Pelly, I. Z.; Lipschutz, M. E.; Balsiger, H.** Vanadium isotopic composition and contents in chondrites: Geochim. et Cosmochim. Acta, v. 34, no. 9, p. 1033-1036, table, 1970.

Vanadium isotopic ratios for terrestrial samples and chondrites of 8 different chemical-petrologic types are the same within the error limits thus indicating no significant

difference in irradiation histories. Determinations of vanadium yield similar concentrations in unequilibrated and equilibrated ordinary chondrites. — Authors' abstract

04634 **Pemberton, R.** Geophysical prospecting in the Wollaston basin area: Canadian Mining Jour., v. 91, no. 5, p. 49-51, illus., 1970.

Discovery of ore-grade uranium mineralization in the Wollaston Lake area, Saskatchewan, in Dec. 1968, by core drilling was based on a 1967 spectrometry survey. Equipment and techniques used are described. Because less than three percent of the area showed visible outcrops, geophysics had to play a major role. In the Athabasca Sandstone part of the basin magnetics and airborne spectrometry were used to search for stratigraphically controlled uranium deposits. Interpretation of an earlier aeromagnetic survey covering the entire basin was undertaken to learn the total thickness of the sedimentary section, to aid in mapping of basement surface topography, and to locate intersedimentary structures that might control emplacement of uraniferous minerals. Combined airborne electromagnetic and spectrometer systems were used on gneissic belts. Ground follow-up programs were planned immediately and parties sent out. — ESL

04467 **Pendery, Eugene.** Distribution of salt and potash deposits — Present and potential effect on potash economics and exploration, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 85-95, illus., tables, 1970.

Geographic and geologic distribution and occurrence of saline deposits are discussed and illustrated. These studies demonstrate that saline deposits underlie surprisingly large areas of the non-shield continental land masses. Location of these deposits, especially in populated areas, will become more and more important as demand grows for salt, potash, storage facilities, and other uses. Depending upon the product or end use desired, geologic, geographic, economic, and market parameters essentially eliminate certain saline basins as prospective exploration and/or exploitation targets. — *from* Author's abstract

04928 **Perkins, Philip L.** Equitability and trophic levels in an Eocene fish population: Lethaia, v. 3, no. 3, p. 301-310, illus., table, 1970.

A collection of fossil fish from the lower Eocene Fossil Lake beds of the Green River Formation in southwestern Wyoming was compared with samples from three modern natural lakes and an artificial fish pond. All fish were divided into predators and planktivores. The predators all had higher equitability (ratio of number of predicted species to number of species observed in sample) and also higher diversity than did the planktivores from the same locality. This suggests that the predators are resource limited (food) and that if migration to and from the lakes is not excessive, the equitability of the predatory forms will eventually stabilize at a higher level than that of the planktivorous forms. The fossil sample follows this pattern, probably from the same causative factors. —*from* Author's abstract

05000 **Pestrong, Raymond.** Environmental trends in geologic education: Jour. Geol. Education, v. 18, no. 5, p. 198-201, 1970.

The importance of understanding the environmental implications of geological problems necessitates training in wide-ranging fields, such as economics, sociology, urban development and law, as well as the usual geology courses, of which geomorphology is considered especially important. The author cites interdisciplinary courses being given at various schools and colleges in California. — EH

04735 **Peter, George.** Discussion of paper by B. P. Luyendyk, "Origin of short-wavelength magnetic lineations observed near the ocean bottom" [1969]: Jour. Geophys. Research, v. 75, no. 32, p. 6717-6720, illus., table, 1970.

The original paper under discussion appeared in Jour. Geophys. Research, v. 74, no. 20, p. 4869-4881, 1969; Abs. North American Geology, March 1970. — DBV

04975 **Peterson, D. L.** A gravity and aeromagnetic survey of Heber and Rhodes valleys, Utah, *in* Water resources of the Heber-Kamas-Park City area, north-central Utah: Utah Dept. Nat. Resources Tech. Pub. 27, p. 54-60, illus., 1970.

A gravity survey was made in Heber and Rhodes Valleys to determine approximate thickness of valley fill and interpret bedrock configuration. The Bouguer map shows an eastward decrease in regional gravity field, interpreted as related mainly to features of greater extent than local valleys. An irregular thickness of low density underlies Heber Valley; three areas of closure, maximum thickness more than 800 feet, are indicated. The northern half of Rhodes Valley is underlain by low density material with a maximum thickness of about 1,600 feet. No magnetic evidence of igneous rock underlying Heber Valley is apparent; however, a small but significant magnetic anomaly was observed over northern Rhodes Valley and is strong evidence that igneous rock underlies this area. Magnetic data suggest an eastward extension of a high amplitude anomaly along the north side of Heber Valley. — MCM

Péwé, T. L. *See* Updike, R. G. 04850

05011 **Péwé, Troy L.; Updike, Randall G.** Guidebook to the geology of the San Francisco Peaks, Arizona, with special reference to the glacial deposits: Plateau, v. 43, no. 2, p. 45-102, illus., tables, 1970.

This guidebook, for Friends of the Pleistocene, Rocky Mountain Section Field Conference 1970, includes a resume of glacial geology and related Quaternary events of the San Francisco Peaks area, and a field trip log with brief description for 40 stops. These mountains, mainly andesite and dacite with some rhyolite, are thought to be Plio-Pleistocene and middle Pleistocene in age. Collapse of a composite volcano and canyon cutting are associated with extensive fans of debris, mud flows and landslides in the flanking Sinagua Formation. A younger blanket of rhyolitic Sugarloaf ash is fluvially reworked downslope. Pleistocene deposits of the Sugarloaf Glaciation and outwash, moraines of the later Core Ridge Glaciation, limited Snowslide Spring Glaciation, and Holocene periglacial deposits are recognized. Correlations are suggested for basalt flow sequences, and for glacial chronology of the Peaks and other areas. — GDC

Phillips, J. D. *See* Uchupi, Elazar. 04745

04993 **Phillips, J. D.; Luyendyk, Bruce P.** Central North Atlantic plate motions over the last 40 million years: Science, v. 170, no. 3959, p. 727-729, illus., table, 1970.

The relative motion vector for the North American and African plates has been determined from detailed charting of the trend of the Atlantis fracture zone for over 1,000 kilometers in the central North Atlantic near 30° N. and from identification of marine magnetic anomalies and deep-sea drilling results. The vector (pole) is located at 52.5° N., 34° W. and has a magnitude (opening rate) of 5.7×10^{-7} degree per year. Major changes in either the pole location or the opening rate are not evident for the last 40 million years. — Authors' abstract

04678 **Phleger, Fred B.** Foraminiferal populations and marine marsh processes: Limnology and Oceanography, v. 15, no. 4, p. 522-534, illus., tables, 1970.

Relation of low-marsh and high-marsh foraminiferal populations to mean tide levels can be used to estimate tidal regime, current velocities, and water exchange in a coastal lagoon if its area and bathymetry are known. In tropical, temperate, and subarctic areas studied, including Gulf of Mexico and Pacific coast of North America, the least diverse faunas have agglutinated tests and occur in high runoff areas and, by displacement, in adjacent environments; the most diverse faunas contain abundant calcareous lagoon and open-ocean species and result from invasion of a low runoff area by undiluted marine water. Fast deposition of detrital sediment is reflected in high ratios of living specimens to empty tests. Some strongly hypersaline marshes support large populations of calcareous species. Calcareous tests may not be preserved in ancient marsh sediments because of low pH below the surface. — *from* Author's abstract

04835 **Phleger, Fred B.** Foraminifera as indicators of some nearshore processes [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1789, 1970.

Pierce, Charles. *See* Alba, Roy S. 04774

04693 **Pierce, Kenneth L.; Christiansen, Robert L.; Richmond, Gerald M.** The Osprey Formation (Pleistocene) and its Tower Creek Gravel Member, Yellowstone National Park, *in* Changes in stratigraphic nomenclature by the U.S. Geological Survey, 1969: U.S. Geol. Survey Bull. 1324-A, p. A30-A34, illus., 1970.

04805 **Pierce, Robert L.** Reducing land subsidence in the Wilmington oil field by use of saline waters, *in* Saline water symposium: Water Resources Research, v. 6, no. 5, p. 1505-1514, illus., 1970.

The subsidence at Long Beach encompassed an area of 22 sq mi, sinkage ranging from 2 feet to 30 feet. It is attributed to pressure reduction due to oil withdrawal from the Wilmington field, and injection of saline water has stopped it. The injection has also developed an economic waterflood project. Water quality control learned over the years is being used to prepare oil field brines for injection instead of disposal into harbor waters, by filtration, recycling, and blending. Through December 1969, 2.5 billion barrels of saline water have been injected into the oil field, the bulk of which was ocean water. — *from* Author's abstract

04506 **Pierce, William G.** Geologic map of the Devils Tooth quadrangle, Park County, Wyoming: U.S. Geol. Survey Geol. Quad. Map GQ-817, scale 1:62,500, sections, 1970.

04761 **Pierson, J. R., Jr.** Fordoche Field, Pointe Coupee Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 9-9g, illus., 1970.

Pilson, M. E. Q. *See* Betzer, Peter R. 04743

04538 **Pimm, Anthony Charles.** Deep sea drilling: Sci. Jour., v. 6, no. 7, p. 61-67, illus., 1970.

The *Glomar Challenger*, in its initial deep drilling program across the Atlantic and Pacific Oceans, gathered evidence in support of sea floor spreading since early Cretaceous time. Paleontologic ages of core samples almost fit those predicted from magnetic anomaly patterns. Spreading rates, estimated in different areas, were greatly accelerated on the East Pacific Rise from Eocene to middle Miocene, then reduced. In the Pacific, far west, Jurassic sediments indicate a change in direction of spreading. Sampled sound reflectors were chert, generally widely distributed except in the South Atlantic; seismic knolls in Gulf of Mexico are salt-dome caprocks saturated with oil and gas. Calcareous fossils are abundant in Cretaceous sediments, but their dissolution in deeper water is indicated by barren Tertiary clays at same sites. Extension of the project hopefully will include basalt cores, oceanic margins, trenches, and smaller seas. — GDC

Pings, W. B. *See* Paist, Donald A. 05074

05086 **Pohn, H. A.; Offield, T. W.** Lunar crater morphology and relative-age determination of lunar geologic units — Pt. 1, Classification, *in* Geological Survey research 1970, Chap. C.: U.S. Geol. Survey Prof. Paper 700-C, p. C153-C162, illus., tables, 1970.

Lunar craters appear to occur in a morphologic continuum from very sharp to very subdued; superposition relations show that younger craters are fresher in appearance than older craters. The assumption is made that morphology correlates generally with crater age. Change in crater form with time probably occurs as a result of mass wasting, mantling, and structural modifications effected by micrometeorite and meteorite bombardment, volcanic processes, and crustal vibrations. Craters in three size classes have been assigned relative ages expressed as decimals in an arbitrary scale — 0.0 (oldest) to 7.0 (youngest) — on the basis of a detailed succession of

morphologic differences attributed to aging processes. Criteria used are preservation of rays, radial ejecta facies, and satellitic craters; rim-crest sharpness and rim texture; and development of terraces and interior radial channels. Type examples of crater stages of defined age are established as a basis of comparison in determining relative ages of craters anywhere on the moon. — *from* Authors' abstract

Pohn, H. A. *See* Offield, T. W. 05087

Polický, Josef. *See* Kudělasek, Vladimír. 04537

04891 **Powell, C. McA.** Intrusive sandstone dykes in the Siamo Slate near Negaunee, Michigan — Reply [to discussion of 1969 paper by N. C. Janke, 1970]: Geol. Soc. America Bull., v. 81, no. 10, p. 3181-3183, 1970.

For the paper under discussion *see* ibid., v. 80, no. 12, p. 2585-2594, 1969; Abs. North American Geology, May 1970.

Prada, K. E. *See* Uchupi, Elazar. 04745

04882 **Pratt, Richard M.** Granitic rocks from the Blake Plateau: Geol. Soc. America Bull., v. 81, no. 10, p. 3117-3121, illus., 1970.

Erratic rocks were recovered by twelve dredge hauls from the Blake Plateau, off the southeastern coast of the United States. Fifty-two percent of the rocks are granitic or granitic gneiss completely foreign to the carbonate plateau. The presence of the granite is best explained by tree rafting from the Guiana Shield area of northeastern South America. Lack of manganese staining and the unweathered nature of the erratics suggest a Pleistocene age for the rocks. — Author's abstract

04728 **Press, Frank.** Regionalized earth models: Jour. Geophys. Research, v. 75, no. 32, p. 6575-6581, illus., 1970.

H. Kanamori's [1970] regionalized phase velocities are combined with other geophysical data to obtain families of models appropriate for an Earth with oceanic, shield, or tectonic crust and upper mantle. A dense lithosphere is found, about 70 km thick under oceans and twice as thick under shields. The asthenosphere and transition zone may be chemically homogeneous except for the lowest phase transition, for which an increase in the Fe/Mg ratio is suggested. The lower mantle is either constant in Fe/Mg or decreases in this ratio with depth. — Author's abstract

Proctor, Cleo V., Jr. *See* Fisher, William L. 04823

04453 **Prodehl, Claus.** Seismic refraction study of crustal structure in the western United States: Geol. Soc. America Bull., v. 81, no. 9, p. 2629-2645, illus., table, 1970.

A network of 64 seismic-refraction profiles recorded by the U.S. Geological Survey in western United States is reinterpreted. Velocity-depth functions are calculated for each profile, and the crustal structure is presented on contour maps and a fence diagram. Crustal thicknesses vary somewhat from the previous interpretations. Velocity inversions within the upper crust are indicated under the southern Cascade Mountains and the middle Rocky Mountains but not under the Sierra Nevada. — AG

Puchelt, Harold R. *See* Schock, Hans H. 04637

04527 **Pye, E. G.** Current activities and trends in exploration in Ontario: Canadian Mining Jour., v. 91, no. 4, p. 112-118, illus., 1970.

Recent exploration in Ontario is directed largely toward nonferrous base metal and uranium deposits, and to a lesser extent toward precious metals, iron, construction materials, and industrial minerals. Copper-nickel, non-nickeliferous base metal sulfide, and uranium deposits are described. Other commodities mentioned are gold and silver, iron, and industrial minerals. Limiting factors affecting the forecast of future developments are: mineral economics, mining and processing technology, prospect-

ing techniques, changing geologic concepts, and areas favorable to exploration. — ESL

Quinlivan, W. D. *See* Carr, W. J. 04690

Rabagay, T. V. *See* Ehmann, W. D. 04781

Rabson, Gustave. *See* VanDiver, Bradford B. 05019

04837 **Rainwater, E. H.** Regional stratigraphy and petroleum potential of Gulf Coast Lower Cretaceous [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1790, 1970.

04838 **Rainwater, E. H.** Stratigraphy and petroleum potential of Peninsular Florida and southern Georgia [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1790, 1970.

04575 **Ramberg, Hans.** Experimental and theoretical study of salt-dome evolution, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 261-270, illus., tables, 1970.

The chief experimental study has been performed by means of more or less realistically scaled models run in a large-capacity centrifuge in which the centrifugal force imitates the force of gravity. A large number of realistically-looking dome-type structures have thus been produced in layered models in which rather stiff materials simulate rock strata. Coherent flow as well as cataclastic processes occur during the runs, thus giving the models a natural appearance. Application of scale model theory permits one to calculate the time of evolution of natural sized domes on the basis of the small centrifuged models. Complementary to the experimental work fluid-dynamic theory has been applied to the domal process. Theory and experiments show in general consistent results. — *from* Author's abstract

04614 **Ramsell, J.** IBM computers in exploration and development: Canadian Mining Jour., v. 91, no. 4, p. 101-103, 1970.

Under ideas and concepts three points are brought up: the computer has no intuitive capability, the interaction between man and machine must be as convenient as possible, and tasks that are not computer oriented should not be forced into mechanical processing. There are three areas in exploration and development where computers can be useful: the broad search for target areas, the qualification of suitably identified areas by more extensive exploration, and evaluation of results from current projects. Computers are aiding the search for new minerals in drill core analysis, contour mapping, and cross-section construction. In development they aid in ore reserve calculation. The time-shared computers combined with a teleprocessing facility have a potential for expanding their use, and search and retrieval time can be cut by use of computer graphics. — ESL

Raney, Jay Alan. *See* McGill, George E. 04944

05014 **Rao, J. S.; Sengupta, Surpriya.** An optimum hierarchical sampling procedure for cross-bedding data: Jour. Geology, v. 78, no. 5, p. 533-544, tables, 1970.

Commonly used techniques for hierarchical or multistage sampling of crossbedding foreset azimuths are based on the conventional analysis of variance. It is now known that the classical method of analysis of variance (ANOVA) cannot be indiscriminately applied for the analysis of circularly distributed data. An efficient and economical sampling technique for crossbedding data has been developed using the circular measures of dispersion and the approximate ANOVA of Watson. The technique is illustrated with the pilot-survey data of the fluviatile Kamthi formation. The following sampling problems have been solved: (1) the minimum sample size required for estimating, with a desired precision, the mean direction of a formation, (2) the optimum allocation of the samples between and within the outcrops that would allow efficient sampling at minimum cost. — *from* Authors' abstract

04466 **Rau, Jon L.; Dellwig, Louis F.** (editors). Third symposium on salt — V. 2, Evaporated salt, solar salt, economic aspects, salt applications, rock physics-mechanics, subsidence, geophysics, hydraulic fracturing, mining: Cleveland, Ohio, Northern Ohio Geol. Soc., 486 p., illus., tables, 1970.

This second volume of the third symposium contains six papers on evaporated salt, four on solar salt, seven on salt economics, nine on salt applications, seven on rock physics and mechanics, four on subsidence, five on geophysics, six on hydraulic fracturing, and five on mining. Those dealing with geological aspects are cited separately by author. — HRC

04562 **Rau, Jon L.; Dellwig, Louis F.** (editors). Third symposium on salt — V. 1, Stratigraphy-sedimentation, geochemistry, tectonics, solution mining, underground storage-disposal: Cleveland, Ohio, Northern Ohio Geol. Soc., 474 p., illus., tables, 1970.

The third symposium on salt, held in Cleveland in 1969 was more international in scope than the previous two symposia. Thirty-two of the 46 papers in volume 1, and one abstract are cited separately. — MCM

Raup, Omer B. *See* Dyni, John R. 04569

04643 **Raup, Omer B.; Hite, Robert J.; Groves, H. Leon, Jr.** Bromine distribution and paleosalinities from well cuttings, Paradox Basin, Utah and Colorado, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 40-47, illus., 1970.

Stratigraphic profiles constructed from bromine analyses of cuttings from two wells in the Paradox basin show basin-wide salinity cycles; the well located closer to the basin center has a higher average bromine content than the well closer to the shelf, indicating a salinity gradient within the halite facies. Bromine content was determined for 657 halite samples from 26 of 29 depositional cycles of the Paradox Member, Pennsylvanian Hermosa Formation by X-ray fluorescence; values ranged from 30-316 ppm. Profiles from well cuttings closely resemble those obtained from cores. Average bromine content calculated for stratigraphically correlated intervals for each salt bed was used as an index for comparing relative salinities. Good correlation between salt beds with high average bromine content and those known to contain potash salts indicates the potential of bromine distribution studies in the search for potash. — *from* Authors' abstract

Rea, David K. *See* Naugler, Frederic P. 04883

04788 **Rea, W. J.** Andesites of the Lesser Antilles: Geol. Soc. London Proc. 1969, no. 1662, p. 39-46, discussion, 1970.

Relative proportions of rock types vary considerably between islands and between volcanoes. Andesites are either two-pyroxene or hornblende-hypersthene. No inclusions of mantle origin are found in lavas, but ultrabasic inclusions are found in andesitic pyroclastics erupted with large amounts of basalt. Interisland variation in andesite chemistry is small except for potash which shows extreme variation. Removal of ultrabasic cumulates from the average basalt will give material close to the composition of the average two-pyroxene andesite. For volcanoes with no basalt or ultrabasic blocks, alternative methods of andesite formation must be considered. Source material of andesites and basalts was probably very similar. Partial melting of sedimentary material and oceanic tholeiite carried into the upper mantle along the Benioff Zone is a possible mechanism, and will explain all chemical features of the andesites. — ESL

04475 **Rechtien, Richard D.** A high frequency wave generator for application to cavity delineation, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 357-366, illus., table, 1970.

This paper presents results of pilot tests conducted on an electromagnetic seismic shear wave exciter. This exciter was conceived for application to the detection of

subsurface cavitics. By virtue of a pneumatic suspension system the exciter operates at depth on the wall of an 8-inch diameter borehole. This instrument generates broad-band, continuous, random, shear waves which, by reflection, create a steady-state seismic reverberant field. The recorded seismic energy is analyzed by the methods of statistical communication theory using long time averaging. These methods allow the analysis of data which is normally below the noise level of the recording instrumentation. The basic theory of application of this random wave generator to cavity detection is discussed along with current thoughts of the capability of the final detection system. — Author's abstract

05054 **Reed, Edward B.** Disturbed sediments in a small alpine lake in Colorado: Arctic, v. 23, no. 2, p. 136-138, illus., 1970.

At the head of Fern Creek, tributary to Big Thompson River in Rocky Mountain National Park, is a small tarn in a northeast-facing cirque at an elevation of 10,950 feet. Impounding moraine belongs to the Temple Lake stade of Neoglaciation; no bedrock is exposed within the basin. In February 1966 blocks of lake ice were found scattered from shore to top of the moraine, with vectors of mud splashes indicating forceful bottom-sediment removal at the tarn's northeast corner. The lake was revisited in May and each month while ice blocks and snowbanks melted; by July a large boulder not previously seen was exposed at the water's north edge, resting on two smaller boulders which clearly show on airphotos taken in 1946. Fall of the new boulder, an estimated 13 metric tons, from adjacent mountain cliff could have been the disturbing impact. Such an explosive disruption had been witnessed in this park, at Chasm Lake (Enoch Mills, 1915). — GDC

04588 **Reeves, Robert G.; Delo, David M.** (editors). Requirements in the field of geology — Council on Education in Geological Sciences Programs Pub. 5: Washington, D. C., Am. Geol. Inst., 38 p., illus., tables, 1970.

This is the summation of replies to a questionnaire responded to by 1105 earth scientists on a poll to acquire data on current and anticipated abilities required by practicing geologists in all fields, for the purpose of designing and revising undergraduate earth-science curricula. Data from the 280 items in each form are on punched cards and available for retrieval. Data are tabulated. — MCM

04807 **Reid, I. A.; Shastal, J.** Glacier surveys in British Columbia, 1968 — V. 1, English system; V. 2, Metric system: Canada Dept. Energy, Mines and Resources Inland Waters Br. Rept. Ser. 10, V. 1, 26 p., illus.; V. 2, illus., 1970.

Topographic surveys of selected glaciers in western Canada, made by the Water Survey of Canada, are designed to calculate the contribution of a glacier to runoff of an area from the change in volume of the glacier during a given time period and from the amount of ice which flows from the source ice field to the glacier during the same time period. This report summarizes the history of glacier surveys and describes present survey practices. Volumetric changes of the selected glaciers for the period of record, some interpretation of these data, and the most recent glacier maps are included. Separate sets of maps use the English and the metric systems. — EH

Reid R. O. *See* Vastano, A. C. 05026

04998 **Rendu, Jean-Michel M.** Geostatistical approach to ore reserve calculation: Eng. and Mining Jour., v. 171, no. 6, p. 114-118, illus., table, 1970.

There are three types of predictive model developed for ore reserve calculation — deterministic, independent random, and correlated random. The correlated random is more generally known as the geostatistical model, and is characterized by the assumption that ore grades are values taken by regionalized variables generated by a random process with the property that any two of these variables are correlated; that is, samples taken close to each other are likely to have similar grades, and this likelihood will decrease as distance between samples increases. When the coefficients of autocovariance matrix have been determined for a given block of ore and a given set of samples, the best estimate of average grade is calculated. The average

grade estimator is chosen as a linear combination of sample grades; the unbiased, minimum mean squared error, linear estimator obtained is the *kriging estimator* and the corresponding mean squared error the *kriging error*. — VSN

Rennilson, J. J. *See* Holt, H. E. 05109

Richmond, Gerald M. *See* Pierce, Kenneth L. 04693

04564 **Rickard, Lawrence V.** Gamma-ray logs and the origin of salt, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 34-39, illus., 1970.

Stratigraphic relations in the Upper Silurian Salina Group in New York, Pennsylvania, Ohio and Ontario have been determined through study and correlation of 435 samples and gamma-ray logs. Although the Michigan and Appalachian basins are structurally distinct, nearly identical rock units can be recognized. Subsurface units in these basins have been correlated with formations defined from surface exposures. In the Appalachian basin salt beds occur in the Vernon and Syracuse formations; Vernon salts can be traced 300 mi from central Michigan through Ohio and Pennsylvania into central New York. Comparison of gamma-ray logs suggests that thick halite beds formed rapidly relative to deposition of intervening rock layers, supporting the proposition that basin floor subsidence occurs before deposition of salt beds. A hypothetical depositional model suggests that salts formed in both shallow and deep water at rates 100 times those of intervening sediments. — *from* Author's abstract

Riedel, W. R. *See* Sanfilippo, Annika. 04612

04706 **Rigby, J. Keith; Chamberlain, C. Kent; Black, B. Allen.** Mississippian and Pennsylvanian sponges from the Ouachita Mountains of Oklahoma: Jour. Paleontology, v. 44, no. 5, p. 816-832, illus., table, 1970.

Large specimens of the rhizomorine lithistid *Haplistion apletum* n.sp., the tetracladine lithistid *Phacellopegma schizoderma* Finks, and the brachiospongiid lyssakid *Arakespongia mega* n.sp., are described from the Morrowan Wapanucka Limestone, near Hartshorne, Okla. *Arakespongia* n.gen., is a large, open bowl-shaped sponge whose thick walls contain large parietal gaps and are armored with large reflected, somewhat nodose pentacts. A nearly complete, somewhat poorly preserved *Dictyospongia* sp., is described from the middle Atoka Formation. Other protospongioid fragments and hexactine spicules are described from the Late Mississippian and Early Pennsylvanian Wesley and Johns Valley formations at several localities. — *from* Authors' abstract

04627 **Rinehart, John S.** Geysering action in a drilled well, Crump, Lake County, Oregon: Jour. Geophys. Research, v. 75, no. 32, p. 6714-6716, illus., 1970.

Determination of the temperature patterns within Crump well, down to a level of 35 m, has established that geysering is initiated close to that 7-m level when the boiling point curve is penetrated by superheated water. The preheated condition obtaining in the wall of the well following a long interval shortens the time to the next eruption. This effect could explain the bimodal distribution in intervals in some natural geysers. — Author's abstract

04951 **Ringe, Don.** Sub-loess basalt topography in the Palouse Hills, southeastern Washington: Geol. Soc. America Bull., v. 81, no. 10, p. 3049-3059, illus., 1970.

The Palouse Loess of southeastern Washington was deposited on a gently undulating surface of Columbia River Basalt. Resistivity measurements indicate that the loess attains thicknesses in excess of 250 feet in the southwestern Palouse, but thins to less than 100 feet in the northeast. The low, rolling hills of the northeastern Palouse are formed in the areas of thin loess deposited on an almost horizontal basalt surface. The high, steep hills that typify the western and southwestern Palouse are associated with 200 feet or more of loess deposited on a more steeply inclined basalt surface. — Author's abstract

05062 **Rinne, W. W.** Need for saline groundwater data to advance desalting technology, *in* Saline water symposium: Water Resources Research, v. 6, no. 5, p. 1482-1486, tables, 1970.

The use of desalting technology to supplement the water resources in semiarid areas of the United States indicates the need for more detailed information on the quantity and quality of saline groundwater supplies. The disposal of brine, a waste product of all desalting processes, poses a formidable problem at inland plant sites. Present work indicates that solar evaporation ponds and subsurface injection are the preferred methods of disposal. The latter method, if employed, would require more data and information on the geologic and hydrologic features of subsurface formations. Systems studies relating the intake and brine disposal facilities with the desalting process are being conducted to achieve optimum system economics. — Author's abstract

05027 **Riva, John.** Thrusted Paleozoic rocks in the northern and central HD Range, northeastern Nevada: Geol. Soc. America Bull., v. 81, no. 9, p. 2689-2715, geol. map, 1970.

Six major thrust plates are exposed in the HD Range, each with its own characteristic stratigraphy. The lowest plate consists of Ordovician chert overlain by Mississippian quartzite; the succeeding three plates of thin Ordovician-Silurian sections; and the upper two of thin Ordovician-Silurian sections overlain by Pennsylvanian and Permian sedimentary rocks. Directional structures and regional considerations indicate that the lower five plates moved in a SSE direction from sources in southern Oregon and southwestern Idaho in two stages, the first during Late Devonian or Mississippian time (Antler Orogeny) and the second in early Mesozoic time. The uppermost plate was emplaced from a more westerly source in late Mesozoic or Tertiary time as a separate tectonic event. — EHP

Roberts, J. L. *See* Hales, A. L. 04681

04669 **Robertson, David S.; Douglas, Richard F.** Sedimentary uranium deposits: Canadian Mining and Metall. Bull., v. 63, no. 697, p. 557-566, illus., tables, 1970.

Over 90 percent of the western world's uranium ore reserves are in sedimentary rocks. Proterozoic quartz-pebble conglomerates contain about 60 percent of known reserves. The Earth's crust had plentiful quartz, gold, uranium, and pyrite which were deposited as detrital heavy minerals prior to appearance of an oxidizing atmosphere in the late Proterozoic. Epigenetic uranium deposits occur in arkose through the entire geologic column, about 30 percent of the western world's known reserves, and are particularly prominent in semi-arid parts of the United States. They occur in lenticular, permeable stream-laid rocks, precipitated where organic material had accumulated. A significant part of the world's uranium resources are in black shales and lignitic rocks. Uranium concentrations that are potential sources of by-product uranium occur in many phosphorites. — *from* Authors' abstract

04676 **Robertson, James A.** Geology of the Spragge area, District of Algoma: Ontario Dept. Mines Geol. Rept. 76, 109 p., illus., tables, geol. maps, 1970.

The area north of the Murray fault is underlain by granitic rocks, and Huronian sedimentary rocks are exposed in the southern and western parts of the map-area. The Lower, Middle, and Upper Mississagi Formations are raised to formational status. These three, with the Bruce Formation and Bruce Limestone Member of the Espanola, comprise the Bruce Group, which is overlain by the Gowganda Formation of the Cobalt Group. These were folded about an anticlinal axis, and Nipissing-type diabase dikes and sills were intruded. The Cutler batholith was intruded 1,750 m.y. ago. Metamorphic rocks at Spragge and between the Murray fault and the batholith were thought to be Archean, but may be metamorphosed Thessalon Greenstone and Lower and Middle Mississagi. Inclusions of these are common in the batholith. The area has been extensively prospected, especially for uranium and copper. — *from* Author's abstract

04460 **Robinson, Edwin S.** Mechanical disintegration of the Navajo Sandstone in Zion Canyon, Utah: Geol. Soc. America Bull., v. 81, no. 9, p. 2799-2806, illus., 1970.

Mechanical disintegration of sandstone cliffs produces column recesses, projecting plates, and arches. The disintegration is in part produced by frost action, rain runoff, seep and stream undercutting and gravity stresses. Estimates of the quantity of material that could be released by failure of suspended columns and projecting plates were computed from elastic considerations and values of 20 kgm/cm² and 700 kgm/cm² taken to be representative of the tensile and crushing strength of the sandstone. — *from* Author's abstract

04839 **Robinson, Gray S.** Change of bathymetric distribution of genus *Cyclammina* [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1790, 1970.

04813 **Röen, Ulrik.** Aksel Nörvang (1914-1968): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 9, p. 1757-1758, portrait, 1970.

05072 **Roessingh, Hank.** Data storage and retrieval, or how to manage overgrown files: Canadian Petroleum, v. 11, no. 9, p. 22-25, illus., 1970.

Only recently have systems of storage and retrieval become generally available. Quality of the data put into the system determines the value of the output. International PetroData had a committee of geologists agree on formation tops picked from well logs, and used these as guides. Services supplied by this company are listed. Canadian Stratigraphic Service has been logging well samples for 20 years, and trains geologists for six months before allowing them to log independently. The well data are now transferred to tape, and the retrieval programs available are listed. Systems available in the United States include those of Scientific Software Corporation, whose PACE system resembles one offered by PetroData. This is recommended for reserve calculation and trend analysis. VISTA III produces contoured maps, computed logs, statistical analysis, and tabular data. The possibilities of TV in these programs are considered. — ESL

04656 **Roldán-Quintana, Jaime.** Estudio geológico de reconocimiento de la región de Peñón Blanco, Estado de Durango [Reconnaissance geologic study of the Peñón Blanco region, State of Durango]: Soc. Geol. Mexicana Bol. 1968, v. 31, no. 2, p. 79-105, illus., table, 1970.

The study area lies between the Sierra Madre Oriental and the Sierra Madre Occidental in central-eastern Durango. The oldest rocks are Cretaceous marine sediments underlying Tertiary volcanic rocks which are covered by Quaternary alluvial deposits. Two intrusive stocks produce contact metamorphism in Mesozoic rocks. The marine rocks were folded during the Eocene Hidalgoan Orogeny, were intruded and then eroded. Volcanic activity, starting at the end of the Oligocene, intensified in the Miocene. In the Pliocene, another period of erosion occurred, followed by alluvial deposition in the Quaternary. Metallic ore deposits include cassiterite in rhyolites and rhyolitic tuffs, and limonite and hematite accompanied by sulfur, in limestones. Wollastonite, kaolin, and chalcedony are also present. The hydrogeology of the area is briefly described. — *from* Author's abstract

04498 **Romer, Alfred Sherwood.** The vertebrate body (4th edition): Philadelphia, Pa., and London, England, W. B. Saunders Co., 601 p., illus., tables, 1970; originally published 1949.

Although this is primarily a textbook of vertebrate anatomy, of particular paleontologic interest are the chapters on: the vertebrate pedigree, and who's who among the vertebrates. — MCM

05130 **Rose, Arthur W.** Origin of trace element distribution patterns in sulfides of the Central and Bingham districts, western U.S.A. [with German abs.]: Mineralium Deposita, v. 5, no. 2, p. 157-163, illus., table, 1970.

Trace-element abundances in sulfides of these two large hydrothermal ore districts allow distinction of several groups of ore bodies with differing trace-element levels. Within groups, certain elements show lateral or vertical zoning. The groups were deposited from different batches of ore fluid. The differences in trace-element content between groups reflect differences in stage of differentiation or abundance of

complexing species when the ore fluid separated from the magma. The zoning may result from "hydrothermal differentiation" of a single batch of ore fluid as it travels away from the magma. The zoning pattern correlates in part with expected strength of metal complexes, but also depends on temperature and solid-liquid partition coefficients. — Author's abstract

04459 **Rose, Peter R.** Stratigraphic interpretation of submarine versus subaerial discontinuity surfaces — An example from the Cretaceous of Texas: Geol. Soc. America Bull., v. 81, no. 9, p. 2787-2797, illus., 1970.

Studies of modern carbonate sediments indicate that submarine cementation is a widespread, on-going process, and that sediments cemented recently beneath the sea are now being eroded by marine currents and bored by marine organisms. By analogy, many ancient carbonate rocks may have been cemented in a similar way, and many discontinuity surfaces, corrosion zones, or "hard grounds" may have formed under submarine conditions. The interpretation of discontinuity surfaces in the Edwards Formation (Lower Cretaceous) of Texas as submarine, rather than subaerial, in origin leads naturally, to wide differences in correlation, stratigraphic interpretations, quantitative map values and interpreted geologic history. Features of vertical and lateral rock sequences, and regional relationships can help distinguish submarine from subaerial discontinuity surfaces. — Author's abstract

Rose, William I., Jr. *See* Stoiber, Richard E. 04873

04858 **Roseman, Mike.** Sixth day road log from Cedar City, Utah to Holbrook, Arizona, via Long Valley Junction, Kanab, Jacob Lake, Marble Canyon, Moenkopi, Keams Canyon and Bidahochi, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 123-131, 1970.

Rosendahl, B. R. *See* Campbell, J. F. 04489

05127 **Rothstein, Arnold J.** Deep ocean nodule mining: Underwater Sci. and Technology Jour., v. 2, no. 3, p. 133-137, illus., tables, 1970.

Most recent writings on economic values of benthic nodules are concentrated on the so-called manganese nodule ores accreting on the ocean floor in thousands of feet of water. Chief among the economically viable metals contained in these nodules are nickel, copper, and cobalt. Discussed with an affirmative view are five major questions in the manganese nodule mining dispute: mine location; recovery equipment; processing techniques; market requirements; and exclusive use of the mine site. The program is described of a private industry team for exploring potential mine sites and operational problems in the Atlantic's Blake Plateau area and more currently in the Pacific Ocean. Scanty facts drawn from earlier reports and the work of predecessors are summarized here. — GDC

04665 **Rothwell, G. W.; Eggert, D. A.** A *Conostoma* with a tentacular integument from the Pennsylvanian of Illinois [abs.]: Am. Jour. Botany, v. 57, no. 6, pt. 2, p. 758, 1970.

04525 **Rowe, M. W.** Evidence for decay of extinct Pu^{244} and I^{129} in the Kapoeta meteorite: Geochim. et Cosmochim. Acta, v. 34, no. 9, p. 1019-1028, illus., tables, 1970.

Evidence for the decay of extinct Pu-244 and I-129 has been found in the Kapoeta howardite. Accurate estimates of the amount of Xe-136 ($10.6 \pm 1.3 \times 10^{-12}$ cu cm per g) from Pu-244 fission decay and of the Xe-129 ($4.1 \pm 0.6 \times 10^{-12}$ cu cm per g) from I-129 beta decay are presented. The fission xenon yield in Kapoeta is Xe-131 : Xe-134 : Xe-134 : Xe-136 = $26 \pm 3 : 88 \pm 4 : 91 \pm 5 = 100$, in agreement with yields previously reported by other workers on other meteorites. — Author's abstract

04954 **Royse, Chester F.; Wadell, James S.** Geology of the Verde Valley, Yavapai County, Arizona, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci.,

Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 35-39, illus., 1970.

The Verde Valley is a southeast trending basin between the Mogollon Rim and the Black Hills, a ridge of Precambrian igneous and metamorphic rocks, overlain by Cambrian and Mississippian beds locally. A thick basalt, the Hickey Formation, caps this sequence. The Verde fault paralleling the base of the Black Hills, originated in the Precambrian and has moved as recently as the Miocene, and formed the Black Hills. Remnants of a gravel wedge that spread across the valley can still be seen. The Verde Formation, deposited in a lake formed when lava flows impounded the Verde River, became highly saline and existed in Miocene-Pliocene time. After the lava dams were breached the river became incised sporadically, between times of lateral cutting. At several localities karst structures have formed. — ESL

04488 **Ruch, R. R.; Kennedy, E. Joyce; Shimp, Neil F.** Studies of Lake Michigan bottom sediments — No. 4, Distribution of arsenic in unconsolidated sediments from southern Lake Michigan: Illinois Geol. Survey Environmental Geology Note 37, 16 p., illus., tables, 1970. 0453

Radiochemical separation procedures were used to determine the arsenic content of 89 core and grab samples from southern Lake Michigan. Arsenic was found to accumulate within the upper, or most recently deposited, portion of most of these sediments in concentrations ranging from about 5 to 30 ppm. Areas with high arsenic content were identified from sediment-water interface samples taken west of Benton Harbor, Michigan; east of Waukegan, Illinois; and southwest of Grand Haven, Michigan. Deposition of fine-grained sediments containing appreciable quantities of organic matter occurs at all these locations. Amounts of arsenic observed in the uppermost portions of these sediments generally vary directly with the organic carbon content and are probably a result of man's activities in the watershed surrounding the lake. — Authors' abstract

04583 **Rueffel, Philip G.** Natural sodium sulfate in North America, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 429-451, illus., 1970. 0509

Large deposits of sodium sulfate occur mainly in southern Saskatchewan, but are also in North Dakota, Montana, and Alberta. Sodium sulfate occurs as brine or in beds of intermittent and/or permanent crystals. Most beds are contaminated with various amounts of silt, sand, and decayed organic matter. Soluble impurities such as chlorides, carbonates and bicarbonates of sodium and sulfates of magnesium and calcium are leached from the soil of the runoff area surrounding the deposits. This paper deals with the origin of sodium sulfate, and the physical and chemical aspects related to the industry. — *from* Author's abstract

05051 **Rusch, Wilbert H., Sr.** Human fossils, [Chap.] 9 *in* Rock strata and the Bible record (P. A. Zimmerman, editor): St. Louis, Mo., and London, England, Concordia Publishing House, p. 133-177, 1970. 0490

The attempt to determine man's past has been beclouded by both the evolutionary and creationary approaches. Primate fossils in general and human fossils in particular are comparatively rare and generally fragmentary. Humanoid skeletons can be assigned to two genera, four species, and two subspecies. Of the four species, *Homo sapiens* and *H. erectus* existed simultaneously, and so did *Australopithecus robustus* and *A. africanus*; preliminary evidence that a species of *Homo* coexisted with *Australopithecus*, if substantiated, will show that *Homo* is as old as the oldest known humanoid remains. The differentiation of species within *Homo* is dubious. Fossil evidence supports the conclusion that species of *Homo* similar or identical to *H. sapiens* have existed since the initial appearance of humanoid fossils in the geological record, indicating no support for any schemes of the evolutionary descent of man, either within hominid genera or from primate ancestors. — MCM

0470

04641 **Russell, Kenneth L.** Geochemistry and halmyrolysis of clay minerals, Rio Ameca, Mexico: Geochim. et Cosmochim. Acta, v. 34, no. 8, p. 893-907, illus., tables, 1970.

Clay minerals from the Rio Ameca were used to study chemical interactions between clay minerals and sea water. Results show that the river contributes cations to the sea which are not removed rapidly by reaction with its clay contribution. The number of equivalents of cations per unit weight of river clay remains constant during equilibration with sea water. The CEC of the clay drops by 40 percent after exposure to sea water, most of the exchange sites being occupied by Mg. By analogy with this river, 11 to 40 percent of the K delivered in solution by the average river is removed by clay minerals in rapid halmyrolysis. Mg can be added to the clay other than in exchange sites, probably as magnesium hydroxide, leading to lowering of pH in a clay-water mixture with only a small volume of water. Amorphous material seems unimportant in early halmyrolysis, but may later react with sea water to form authigenic minerals or recrystallize isochemically. — DBV

Ryall, Alan. *See* Douglas, Bruce M. 04685

04536 **Ryder, Robert B.; Cervione, Michael A., Jr.; Thomas, Chester E., Jr.; Thomas, Mendall P.** Water resources inventory of Connecticut — Pt. 4, Southwestern coastal river basins: Connecticut Water Resources Bull. 17, 54 p., illus., tables, 1970.

Ground water can be obtained from three aquifers (stratified drift, till, and bedrock), but only the drift can yield large quantities for industrial and public-supply use. The drift underlies about 15 percent of the area, has a transmissibility of 0 to over 200,000 gpd per ft, is up to 185 feet thick, and yields over 2,000 gpm in some places; five areas are considered favorable for development. The till aquifer has an estimated permeability of about 5 gpd per sq ft and can yield marginally adequate supplies to domestic wells. The bedrock aquifer underlies the basins everywhere; yields range from 3 gpm at most places to 100 gpm for a weathered-marble aquifer which underlies a few small areas. Dissolved solids concentration from wells tapping bedrock and drift ranged from 52-354, and 71-225 mg/*l*, respectively. Objectionable amounts of iron and manganese are found in some samples. — *from* Authors' summary

05095 **Salisbury, John W.** Composition of the Moon from balloon-borne mid-infrared observations, *in* Symposium on planetary atmospheres and surfaces, Woods Hole, Mass., 1969: Radio Sci., v. 5, no. 2, p. 241-246, illus., 1970.

Mid-infrared spectra (7.0 to 13.5μ) of six different areas show significant departures from blackbody or graybody emission. The position of a peak (that varies in wavelength from 8.11 to 8.37μ) varies regularly with type of surface feature in view. Laboratory studies show that the wavelength of peak emissivity in surface emission can be interpreted in terms of rock composition, and that the differences in peak emissivity result from differences in rock type. The data obtained so far indicate that the circular maria, Imbrium and Serenitatis, are ultrabasic in composition whereas the lunar crust appears to be basic in composition. The compositional heterogeneity may explain location of major mascons in the circular maria. — *from* Author's abstract

04908 **Sams, Richard H.** The Kingsville dome, Kleberg County, Texas: Corpus Christi Geol. Soc. Bull., v. 11, no. 1, p. 6-9, 12-17, illus., table, 1970.

On as large a structure as the Kingsville dome, within a highly productive trend, do large reserves remain to be found? If so, how? If not, why? In order to orient the reader for his answer to these questions, a brief history of the exploratory development, a general description of the production, and a description of the major features of the structure and stratigraphy of the Kingsville dome are presented. In addition, an interpretation of the structural evolution of the dome is presented and inferences are drawn concerning the origin of some of the presently known production. — Author's abstract

Sanders, John E. *See* Friedman, Gerald M. 04726

04701 **Sanderson, G. A.; Verville, G. J.** Morphologic variability of the genus *Schwagerina* in the Lower Permian Wreford Limestone of Kansas: Palaeontology, v. 13, pt. 2, p. 175-183, illus., 1970.

Three hundred specimens of *Schwagerina* from six collecting localities in the basal part of the Threemile Limestone Member of the Permian Wreford Formation in Chase County, Kansas, were used in this study. The restricted stratigraphic range and limited geographic distribution of the fusulinid fauna within the intracratonic, cyclical succession tend to minimize the effects of diachronism, and it is presumed that the collections are approximately contemporaneous. Considerable morphologic variability is evident within the Threemile fusulinid fauna, and affinities with several previously described species of *Schwagerina* can be demonstrated. Studies of measurable morphologic parameters suggest that all the Wreford schwagerinids sampled are referable to a single population, and thus the validity of several established taxa is open to challenge. — *from* Authors' abstract

04612 **Sanfilippo, Annika; Riedel, W. R.** Post-Eocene "closed" theoperid radiolarians: Micropaleontology, v. 16, no. 4, p. 446-462, illus., 1970.

Fifteen species of two-, three-, and four-segmented theoperid radiolarians which are closed distally or have very restricted apertures are assigned to the genera *Stichocarys*, *Cyrtocapsella*, *Lithopera*, and *Cyclampterium*,. Most of the species are Miocene, and all are post-Eocene. Nine of them are new, and *Glomaria* is described as a new subgenus of *Lithopera*. Two additional species of *Stichocorys* are discussed in connection with the phylogenetic development of the "closed" forms. — Authors' abstract

04535 **Sangster, D. F.** Geological exploration guides for Canadian lead-zinc deposits in carbonate rocks: Canadian Mining Jour., v. 91, no. 4, p. 49-51, table, 1970.

Choice of target areas in the search for lead-zinc deposits depends to a large extent on recognizing geologically favourable units. Concentrations of ore minerals occur in time-rock units where they are coincident with appropriate paleogeographic position and/or tectonic overprinting. Some conformable orebodies occur peripheral to undeformed sedimentary basins in clean, massive or coarse-bedded, vuggy reefal dolomite and consist of massive or disseminated sulfides. Others are found in intensely deformed, dark, well-bedded dolomite intruded by rocks of granitic to intermediate composition. These bodies are layered and commonly deformed and/or thermally metamorphosed. Effects of tectonic processes on localization of ore in both types of occurrence are discussed. Examples of potential ore-bearing sedimentary basins in Canada, with favorable time-rock and lithologic units, are outlined as prospective exploration targets. — *from* Author's abstract

Santoliquido, P. M. *See* Ehmann, W. D. 04781

Sargent, K. A. *See* McKay, Edward J. 04513

04465 **Saucier, Roger T.** Origin of the St. Francis Sunk Lands, Arkansas and Missouri: Geol. Soc. America Bull., v. 81, no. 9, p. 2847-2854, illus., 1970.

The New Madrid earthquake, a succession of shocks in 1811 and 1812 in the northern portion of the Lower Mississippi Valley, caused earth waves, fissuring, sand blows, landslides, uplift, subsidence, and related phenomena over an area of thousands of square miles. However, considerable doubt is cast over the narrative accounts and evidence cited for assignment of the St. Francis Sunk Lands to the list of earthquake effects. Origin of these features as a result of alluvial drowning of several relict, braided stream channels by a Mississippi River crevasse channel appears to be a more tenable explanation. Excluding the sunk lands from consideration appreciably diminishes the southwestern extent of the area of discernible earthquake effects and helps subordinate the role of topographic and surface geologic features in calculating seismic-risk zonation in the area. – Author's abstract

Savin, Samuel M. *See* Hecht, Alan D. 04673

Sawa, Takashi. *See* Conkin, James E. 04515

Schaem, William E. *See* Eckel, Edwin B. 04962

05007 **Scheidegger, A. E.** On the rheology of rock creep [with German and French abs.]: Rock Mechanics, v. 2, no. 3, p. 138-145, 1970.

The standard (linear) rheological models and the experimental evidence on rock creep are reviewed, and it is shown that a new rheological equation ("stress-strain relation") must be found to describe the most common behavior of rocks. Such a rheological equation is deduced by a correspondence principle with a Kelvin material and is presented. It is nonlinear and of the form: $\sigma = 2\eta\ddot{\epsilon} + \beta\dot{\epsilon}^2$, where ϵ is shear strain, σ shear stress, dot denotes time derivation, and η and β are constants. Some consequences of this equation are discussed. — Author's abstract

04977 **Scheidegger, Adrian E.** Theoretical geomorphology (2d, revised edition): Berlin, Germany, and New York, Springer-Verlag, 435 p., illus., tables, 1970; originally published 1961.

This book, a discussion of the theory of the exogenetic features of the earth, is a supplement to Scheidegger's *Principles of geodynamics*, in which he treats theoretical aspects of the endogenetic features. Some sections of the first edition have been completely rewritten, and the chapter on basin development is completely new. — MCM

05043 **Scheidegger, Adrian E.** The large-scale tectonic stress field in the earth, [Chap.] 10 *in* The megatectonics of continents and oceans (Helgi Johnson and Bennett L. Smith, editors): New Brunswick, N. J., Rutgers Univ. Press, p. 223-240, illus., 1970.

The existence of a tectonic stress field in the earth, which cannot be explained by action of gravity alone, is firmly established. The present field, as inferred from actual measurements and contemporary effects (earthquakes) is in most areas consistent with that inferred from investigation of recent orogenetic activity. The exception, in central Europe, can be explained by postulating very recent change in orogenetic activity. The character, predominantly compression, tension, and shear, of the present field is uniform over large areas, but differs fundamentally from one large region to another. Any geotectonic hypothesis must explain these different fields in widely separated regions. Available evidence of depth dependence of the stress field fails to support decoupling between crust and mantle, but the field seems independent of depth. Also the character of the field seems to have remained fairly static for the last 60 m.y. with the exception in Europe.—*from* Author's conclusion

04519 **Schell, E. M.; Moore, K. P.** Stratigraphic sections and chemical analyses of phosphatic rocks of Permian and Mississippian age in Weber County, Utah: U.S. Geol. Survey Circ. 635, 11 p., illus., tables, 1970.

Stratigraphic sections and phosphatic rocks from five trench localities in Weber County are presented; four of the trenches are in Mississippian, and one Permian rocks. Highest grade phosphatic interval of the Mississippian rocks is at the Wheat Grass Creek locality, where they are 14.9 feet thick; a 5.8-ft-thick zone has an average of 22.1 percent P_2O_5. Three localities have 1.1 or less feet of phosphate rock that contains 24+ percent P_2O_5. The Permian Park City Formation and related strata, where measured in Hardy Hollow, are 675 feet thick and consist of a 10.9-ft-thick phosphatic interval in the Grandeur Member of the Park City; the Meade Peak Phosphatic Shale Tongue of the Phosphoria Formation is 171 feet thick, but is cut by numerous faults. — *from* Authors' abstract

Schelske, J. E. *See* Morawski, F. P. 04801

04680 **Schlemer, E. W.; Schubel, J. R.** A near-bottom suspended sediment sampling system for studies of resuspension: Limnology and Oceanography, v. 15, no. 4, p. 644-646, illus., 1970.

Studies of resuspension of bottom sediments by tidal scour require periodic collection of samples at several levels close to the bottom. For studies of sediment resuspension in Chesapeake Bay, a bottom-mounted rod, implanted by free fall, supports intakes for pumping water samples from six fixed levels above the bottom. All

of the sampling tubes are purged continuously by the pumping system to prevent trapping of sediment in the intakes, and samples are selected with a specially designed 6-way rotary valve. — VMJ

04880 **Schneider, Allan F.** A significant Pleistocene exposure in south-central Indiana: Geol. Soc. America Bull., v. 81, no. 10, p. 3079-3083, illus., 1970.

A 50-ft exposure of unconsolidated deposits near Trevlac, Indiana exhibits the most complete Pleistocene sequence in south-central Indiana. The section includes basal till interpreted as Kansan, sand and gravel regarded as Illinoian outwash, and a capping of silt considered Wisconsinan. — RGY

Schnitzer, Morris. *See* Ogner, Gunnar. 04558

04637 **Schock, Hans H.; Puchelt, Harold R.** Distribution of Rb and Cs in potassium salts, experimental and analytical investigations, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 232-238, illus., tables, 1970.

The distribution coefficients of Rb and Cs were obtained for atomic ratios (Mg/K) × 5.4 in saturated solutions at 40°C. Radioactive tracers were used in the analytical technique. An increase in incorporation of Cs and Rb with decreasing temperatures was indicated. At temperatures below 30°C the partition coefficient for Cs becomes greater than unity. With increasing (Mg/K)-ratio, both coefficients decrease. — HRC

Schoelen, John. *See* Bell, John. 04758

04540 **Scholl, David W.; Marlow, Michael S.** Diapirlike structures in southeastern Bering Sea: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 9, p. 1644-1650, illus., 1970.

Six diapirs or diapirlike folds have been located by seismic reflection profiling beneath the edges of Umnak Plateau, a broad platform at a depth near 1,860 m in the southeastern Bering Sea. The plateau is underlain by 2,000-3,000 m of flat-lying Neogene strata which overlie an 'acoustic basement' of Paleogene or Cretaceous rocks. Piercement cores rise as much as 1,500 m above acoustic basement and to within 700 m of the sea floor; folding above them decreases upward. Cores do not produce a clearly recognizable magnetic anomaly and thus may not be igneous in origin, although such an origin is suggested by proximity to volcanic and intrusive rocks of late Cenozoic age on the Aleutian Ridge and Botoslof Island. They may consist of shale or could be salt diapirs. — *from* Authors' abstract

Schubel, J. R. *See* Schiemer, E. W. 04680

Schulte, Kenneth C. *See* Minch, John A. 04885

04708 **Schultz, Gerald E.; Cheatum, Elmer P.** *Bison occidentalis* and associated invertebrates from the late Wisconsin of Randall County, Texas: Jour. Paleontology, v. 44, no. 5, p. 836-850, illus., table, 1970.

A skull of *Bison occidentalis*, lacking dentition and palatal region, was collected from an organic clay deposit in the upper reaches of Palo Duro Canyon. The horn cores are complete; the spread is 775 mm. Associated with the skull were remains of small fish, ostracodes, two species of pelecypods, and 23 species of freshwater and land gastropods, which together constitute the McCormick local fauna. Radiocarbon dating of the mollusks gave an age of 10,800 ± 835 yr B.P. From a quantitative analysis of the gastropods, it is quite obvious that the area was marshy with considerable standing water and had a climate much cooler with greater rainfall than that which prevails today. — *from* Authors' abstract

04683 **Schwab, Fred.** Surface-wave dispersion computations — Knopoff's method: Seismol. Soc. America Bull., v. 60, no. 5, p. 1491-1520, illus., tables, 1970.

The optimization of Knopoff's method for computer computation of surface-wave dispersion, and the comparison of this method with the Thomson-Haskell technique and its extensions are studied. A new representation of the Rayleigh-wave dispersion function is devised which is more powerful than the most powerful of the Thomson-Haskell version. Explicit forms of the new representation are given for the layered-half-space analogs of continental and oceanic models of the Earth, also for symmetric and antisymmetric modes of the summetric-plate analog of the Earth. When written out fully, all functions are identical; the techniques differ only in their matrix representations of the dispersion function. The Knopoff and Thomson-Haskell techniques for computing Love-wave dispersion are compared. The functions are identical, except for a possible sign reversal; the speeds of computation are also identical. — DBV

04650 **Schwarcz, H. P.; Clayton, R. N.; Mayeda, Toshiko.** Oxygen isotopic studies of calcareous and pelitic metamorphic rocks, New England: Geol. Soc. America Bull., v. 81, no. 8, p. 2299-2315, illus., tables, 1970.

Oxygen isotope fractionations between coexisting quartz and calcite (ΔQC) have been measured in calcareous quartzites, quartz-calcite veins, metavolcanic rocks and marbles collected throughout Vermont. In general ΔQC decreases with metamorphic grade up to the upper garnet zone. Calculated maximum temperatures agree with inferred values. Whole rock isotopic compositions appear to be inherited from a mixture of marine limestone, sand, and shale and are independent of metamorphic grade. — *from* Authors' abstract

04621 **Schwarz, E. J.; Symons, D. T. A.** Paleomagnetic field intensity during cooling of the Sudbury irruptive 1700 million years ago: Jour. Geophys. Research, v. 75, no. 32, p. 6631-6640, illus., tables, 1970.

Thirty-three oriented cores were taken along a 300-m section of felsic norite in the Sudbury irruptive, Canada. Polished section, thermomagnetic, and electron microprobe investigations show that the norite has a uniform magnetic mineral assemblage of virtually pure magnetite and ilmenite, having a narrow range of blocking temperatures (420-540°C) and probably formed above 540°C. Two specimens from each core were analyzed, and yielded 51 acceptable paleointensity and inclination values. Within-core paleointensity variation is significantly less than between-core. Mean local paleointensity and -inclination are 0.24 ± 0.06 oe and $64 \pm 8°$, respectively. The paleointensity and -inclination variations seem to be caused by variations in the Earth's dipole moment, except in a 50-m interval where intensity variation can be related to variations in local inclination. — DBV

04580 **Schwerdtner, W. M.** Relationships between anhydrite mineral lineations and directions of megascopic strain, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 317-326, illus., 1970.

Anhydrite lineations are invariably parallel to the direction of maximum sectional extension, along the dominant planar discontinuity. Hence, mineral lineations in schistose anhydrite can be used as strain-direction indicators in geological mapping. The trajectories of principal finite extension will generally be somewhat oblique to lineation directions, which reduces their usefulness in structural analysis. Existing anhydrite lineations may have been bent by flexural slip or rigidly displaced by rotational faulting. However, lineations will always be parallel to sectional extension directions, referred to internal coordinates of rock "specimens", although they may no longer correspond with regional extension directions, referred to geographic coordinates. — *from* Author's abstract

Scott, Martha R. *See* Berner, Robert A. 04679

05110 **Scott, R. F.; Carrier, W. D.; Costes, N. C.; Mitchell, J. K.** Preliminary geologic investigation of the Apollo 12 landing site, — Pt. C, Mechanical properties of the lunar regolith, *in* Apollo 12 preliminary science report: U.S. Natl. Aeronautics and Space Adm. Spec. Pub. SP-235, p. 161-182, illus., 1970.

This report presents a soil mechanics point of view of the Apollo 12 returned data, and comparisons with the Apollo 11 site. The gross mechanical properties of the two sites are not greatly different; the Apollo 12 soil appears to become coarser with depth. The astronauts noted three distinct areas along the second EVA traverse, with some aspects quite unlike those of the Apollo 11 site. Color variations were evident; the material did not appear to be homogeneous with depth at all locations. Adhesive qualities and the tendency of the loose, powdery surface material to move easily in the lunar vacuum imposes operational problems. There appears to be no direct correlation between crater slope angle and consistency of soil cover. — JHF

Searles, Leonard C. *See* Lafayette Geological Society. 04752

04687 **Seeber, Leonard; Barazangi, Muawia; Nowroozi, Ali.** Microearthquake seismicity and tectonics of coastal northern California: Seismol. Soc. America Bull., v. 60, no. 5, p. 1669-1699, illus., tables, 1970.

This study demonstrates that high-gain, high-frequency portable seismographs operated for short intervals can provide unique data on details of current tectonic activity in a very small area. Five such instruments were operated at 25 sites along the coast of northern California in the summer of 1968. The microearthquake focuses lay almost exclusively at depths between 15 and 35 km, significantly greater than those reported elsewhere along the San Andreas fault system. The first motion directions, composite fault plane solutions, and other evidence support the hypothesis that dextral strike-slip motion along the San Andreas fault is currently being taken up by slip along the Mendocino escarpment as well as by slip along northwest-trending faults in the Gorda basin. — DBV

Seki, Yotaro. *See* Ernst, W. G. 05079

05031 **Sellers, J. B.** Rock mechanics instrumentation for salt mining, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 236-248, illus., 1970.

Instruments for measuring deformations are the tape extensometer in conjunction with borehole extensometers of both the rod and wire varieties. For measuring rock stresses the instruments discussed are the photoelastic stressmeter and hydraulic borehole gauges. Rock bolt tension meters are also described. Where possible, enough information is given to enable the engineer to build much of his own equipment. The methods in which the instruments should be used are discussed with practical examples of how certain conditions of instability can be detected. — *from* Author's abstract

Sengupta, Surpriya. *See* Rao, J. S. 05014

05034 **Serata, Shosei.** Prerequisites for application of finite element method to solution cavities and conventional mines, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 249-279, illus., 1970.

The first requirement is to establish the constitutive equations of rock salt and adjacent rock media based on laboratory tensor analysis. The second is a laboratory model technique for analyzing the interaction between the tensor properties of the materials and a given three-dimensional geometry of the underground. The third requirement is the field technique of stress-strain distribution analysis of boreholes and mine structures which enable the field evaluation of the finite elemental program for true underground conditions. Different techniques are developed for the solution cavity and conventional salt mine studies because of the basic difference in the rock mechanics conditions between the two. — *from* Author's abstract

04918 **Shannon, Frank G.** Some unique geological features at the Bluebell mine, Riondel, British Columbia, [Chap.] 10 *in* Lead-zinc deposits in the Kootenay Arc, northeastern Washington and adjacent British Columbia — Soc. Econ. Geologists, 1970 Northwest Field Conf. Guidebook: Washington Div. Mines and Geology Bull. 61, p. 107-120, illus., 1970.

Four areas of unique geologic interest are: mineralization and mode of occurrence, structural control of distribution, oxidation at depth under a sulfide cap, and thermal springs with heavy emission of CO_2. The one common feature in all types of ore bodies is the mineralized tension fracture. It is concluded that, in the Bluebell Limestone, given a deep-seated source, any physical feature increasing the porosity or permeability of the rock will exert control on ore deposition. A block diagram and diagrammatic cross sections are included. Four areas of major oxidation are described and explained as due to meteoric waters from the depths of Kootenay Lake and the Tertiary ancestral drainage system. Thermal springs, contributing about half of the 5,200 gpm pumped from the mine, are confined mainly to the limestone. They deposit almost pure $CaCO_3$ and do not have an oxidizing effect; analyses show a higher chlorine content than nearby surface waters. — ESL

Shastal, J. *See* Reid, I. A. 04807

04579 **Shea, F. S.** Salt basins in Nova Scotia, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 306-316, illus., 1970.

The Lower Carboniferous system contains practically all of the various industrial minerals produced in Nova Scotia. Based on data accumulated through geological and geophysical work, drilling in a number of Windsor marine basins was carried out as a preliminary or pilot program to more detailed surveys. In all areas drilled and studied, salt has been discovered. Evidence to date suggests that all known salt deposits occur in the form of steeply dipping tabular or brecciated bodies of rock salt having unknown thickness, extent, and grade. Faults of a variety of magnitudes are present. The effects of these faults on the deposits are yet generally unknown. — *from* Author's abstract

04567 **Shearman, Douglas J.** Crystal fabrics in calcium sulphate deposits [abs.], *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 119, 1970.

04485 **Sheikh, A. Mannan.** Geology and ore deposits of Las Guijas tungsten district, Pima County, Arizona: Econ. Geology, v. 65, no. 7, p. 875-882, illus., 1970.

In the Las Guijas tungsten district, 58 mi southwest of Tucson, Arizona, granite and volcanic breccia occupy most of the area and serve as host rocks. There is a series of vertical faults consisting of a N-S system (post-mineralization) and an E-W system (pre-mineralization). Deposits are associated structurally and genetically with the Las Guijas granite stock, and all veins encircle the stock. Wolframite, huebnerite, and scheelite are the principal ore minerals along with sulfides and oxide minerals. Quartz is the prevalent gangue and sericite. Spectrographic analyses indicate elements present in ore minerals and confirm mineral identification. The Las Guijas deposits are classified as epigenetic epithermal deposits. Active mining has ceased. — VSN

Shideler, Gerald L. *See* Swift, Donald J. P. 04724

05115 **Shima, Makoto; Nagata, Takeshi; Okada, Akihiko.** Round particles on the lunar surface [in Japanese with English abs.]: Japanese Assoc. Mineralogists, Petrologists and Econ. Geologists Jour., v. 63, no. 6, p. 239-247, illus., tables, 1970.

Fine materials from the Moon contain many round particles almost identical in shape and size to cosmic dust. These materials are classified into three groups on the basis of chemical composition: Fe-Ni, Fe, and silicate groups. Glassy particles, mainly of silica, are thought to be a type of microtektite found on Earth; it is suggested that part of these spherules are extraterrestrial matter. — *from* Authors' English abstract

Shimp, Neil F. *See* Ruch, R. R. 04488

04840 **Shinn, Anthony D.** Possible future petroleum provinces of Gulf Coast, upper Miocene-Pliocene [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1790-1791, 1970.

05091 **Shoemaker, E. M.; Morris, E. C.** Physical characteristics of the lunar regolith determined from Surveyor television observations, *in* Symposium on planetary atmospheres and surfaces, Woods Hole, Mass., 1969: Radio Sci., v. 5, no. 2, p. 129-155, illus., 1970.

The new data on the physical characteristics of the lunar surface derived from the Surveyor pictures can be fitted to a simple ballistic model for the origin and development of the lunar regolith. The thickness of the regolith can be estimated from observational data. Considering all five sites, a strong inverse correlation is found between the abundance of coarse blocks and the thickness of the regolith. The coarsest fragments are most abundant at the sites with the thinnest regolith.—*from* Authors' abstract

05108 **Shoemaker, E. M.** (and others). Preliminary geologic investigation of the Apollo 12 landing site, — Pt. A, Geology of the Apollo 12 landing site, *in* Apollo 12 preliminary science report: U.S. Natl. Aeronautics and Space Adm. Spec. Pub. SP-235, p. 113-156, illus., 1970.

Mosaics of panoramas taken by Apollo 12 astronauts, and a cross-reference table for samples, photographs, and transcript are presented here. Comments are made on the astronauts' report of a variety of craters and ejecta, ray material, fine-grained materials, large amounts of glass, and linear grooves of varying sizes and depths. Size-frequency distribution of particles and craters is tabulated, and the opinion expressed that the data indicate the Apollo 11 site to be older. Another notable difference between the Apollo 11 and 12 sites is the higher ratio of crystalline rocks to microbreccia at the Apollo 12 site. — JHF

04644 **Sholkovitz, Edward R.** A free vehicle bottom-water sampler: Limnology and Oceanography, v. 15, no. 4, p. 641-644, illus., 1970.

A free vehicle which samples water at 20-cm intervals for the first 2 m above the ocean sediment is described. The free vehicle approach enables closely spaced water sampling just above the ocean sediment interface for studying chemical gradients. [The sampler has four parts: framework; 10 water-sampling bottles; time-release triggering mechanism; flotation and recovery equipment. It has been used successfully six times in the Santa Barbara Basin, off California, at a depth of 560-580 m.] — Author's abstract

Showalter, D. L. *See* Ehmann, W. D. 04781

04500 **Shreveport Geological Society.** Southeast Oklahoma and northeast Texas — 1970 spring field trip, guide book: Shreveport, La., Shreveport Geol. Soc., 33 p., illus., 1970.

The field trip began at Shreveport, La., with the first stop near Tom, Okla., and proceeded to Paris, Tex.; four further stops were made in Texas on the second day. Cretaceous beds in the general area possess lucrative hydrocarbon reservoirs; a better understanding of the sediments at their outcrop should help reveal these reservoirs. — MCM

04973 **Simard, Antoine.** A study of the peat-bogs of Mingan Islands, Duplessis County [also French edition]: Quebec Dept. Nat. Resources Prelim. Rept. 590, 16 p., illus., tables, 1970.

From these islands off the north shore of St. Lawrence Gulf, 450 mi northeast of Quebec City, considerable variation in physical properties and fertilizing components is shown in the tabulated results of analyses of: peat bogs of Mingan Islands; a vast mainland bog near Havre-Saint-Pierre; other peat bogs of the St. Lawrence Lowland; and two types of guano. Almost all peat bogs of the islands are less acidic, higher in ash, richer in nitrogen and calcium than those of the mainland, but low in phosphorus, potassium and magnesium; sodium content is quite variable. Magnesium is in samples from two islands, but marl deposits of all islands are very poor in it. Only humus soil of Perroquets Saint-Charles, and probably other treeless islands, is rich in fertilizer and calcium, but these deposits are too thin. — GDC

Simmons, G. C. *See* Gair, J. E. 04692

05103 **Simmons, Gene; Calio, A. J.** Summary of scientific results, *in* Apollo 12 preliminary science report: U.S. Natl. Aeronautics and Space Adm. Spec. Pub. SP-235, p. 1-6, 1970.

Apollo 12 results obtained before June 1, 1970, are summarized in this section; details are discussed in other chapters of the report. — JHF

04893 **Simpson, George Gaylord.** On randomness and determinism — Discussion [of 'Randomness in nature' by C. J. Mann, 1970]: Geol. Soc. America Bull., v. 81, no. 10, p. 3185-3186, 1970.

For the paper under discussion *see* ibid., v. 81, no. 1, p. 95-103, 1970; Abs. North American Geology, June 1970.

Sims, P. K. *See* Morey, G. B. 04971

05083 **Singer, S. Fred.** Origin of the Moon by capture and its consequences: EOS, v. 51, no. 9, p. 637-641, illus., 1970.

From celestial mechanics calculations based on tidal theory, it is suggested that the Moon was captured from an initially prograde orbit. It is further suggested that although the inherent probability of capture is low, its relative probability in relation to other theories of origin is high. Strong support for the capture theory comes from the need for a heat source early in the history of the Earth. Even stronger support would come from finding that the Earth and Moon experienced simultaneous heating within a few hundred years' interval about 4.5 b.y. ago. Finally, it is suggested that an interpretation of the Earth-facing ringed maria on the lunar surface would provide evidence for the Moon having been very close to the Earth during the early part of its history. — GV

04592 **Singh Deshwar, K. H.** 'E-H' extensometer, a practical instrument for rock mechanics measurements: Canadian Mining Jour., v. 91, no. 7, p. 45-47, illus., 1970.

The 'E-H' extensometer, briefly discussed in this paper, is an electrical instrument which measures the differential movement between two points along the axis of a borehole. This technique has overcome some of the limitations of the mechanical extensometers and can be used to obtain fundamental knowledge of rock behaviour in a specific situation, and to operate as a control instrument for monitoring displacements and for predicting the possibilities of rock failure around mining excavations. — Author's abstract

04552 **Sinkankas, John.** Prospecting for gemstones and minerals (*formerly titled* Gemstones and minerals, how and where to find them): New York, Van Nostrand Reinhold Co., 397 p., illus., tables, revised 1970; originally published 1961.

Chapter headings are: prospecting and collecting trips, tools and how to use them, rock classes and how to recognize them, how mineral deposits form, field features of mineral deposits, collecting practices, preparation of specimens, storage and exhibit, and marketing mineral specimens and gemstones. — MCM

04903 **Skinner, Brian J.** Stability of the tetragonal polymorph of Cu_2S: Econ. Geology, v. 65, no. 6, p. 724-728, illus., table, 1970.

Tetragonal Cu_2S has not yet been found as a mineral, presumably a reflection of the rapidity with which it inverts to chalcocite under normal surface conditions. This phase is, however, to be expected under many conditions in the Earth's crust. The temperature dependence of breakdown of tetragonal Cu_2S at 1 atm pressure arises as a response to two opposing phenomena. At 97°C and atmospheric pressure, the phase is close to its stability field, and the conversion rate is essentially zero. At lower temperatures, it departs further and further from stability, and the conversion rate is proportionally higher, reaching a maximum near 25°C. A point must be reached where the slowing down of reaction rates in response to falling temperature exceeds

the tendency for inversion, and the curve reverses itself and starts declining again. — *from* Author's conclusions

04895 **Smalley, I. J.** Randomness in nature — Discussion [of 1970 paper by C. J. Mann]: Geol. Soc. America Bull., v. 81, no. 10, p. 3191-3193, 1970.

For the paper under discussion *see* ibid., v. 81, no. 1, p. 95-103, 1970; Abs. North American Geology, June 1970.

Smith, Bennett L. *See* Johnson, Helgi. 05036

04848 **Smith, Clay T.** Notes on the geology of the Colorado Plateau, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 21-30, illus., 1970.

In most of the Plateau, Precambrian-Holocene rocks outcrop as flat-lying units. Stratigraphy of the Precambrian, Paleozoic, Triassic, Jurassic, Cretaceous, and Tertiary is described. The Plateau has been a very stable crustal block, having undergone little distortion since the Laramide orogeny, and having been a stable shelf during the early Paleozoic. The western section includes monoclines facing predominently east, and small basins; the eastern section contains the large basins and west-facing monoclines. Intrusions and volcanic activity followed the Laramide orogeny. Current elevation of the Plateau may be related to late Tertiary or Holocene movement along major faults. Minor folding, faulting, and volcanic activity continues to the present. Coal, vanadium, uranium, petroleum, and natural gas are the mineral resources. — ESL

04853 **Smith, Clay T.** (compiler). First day road log from Albuquerque, New Mexico to Cameron Trading Post, Arizona, via the Navajo and Hopi Indian reservations, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 62-78, 1970.

Smith, Clay T. *See* Bowman, Frank O., Jr. 04855

04856 **Smith, Clay T.; Miller, Paul T.; Cooper, Laurence C.** (compilers). Second day road log from Cameron Trading Post, Arizona to Cedar City, Utah, via Desert View, Page, Kanab and Long Valley Junction, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 94-106, 1970.

Smith, Clay T. *See* Bowman, Frank O., Jr. 04859

04860 **Smith, Clay T.** (compiler). Sixth day road log from Cedar City to Moab, Utah, via Parowan, Kingston, Capital Reef National Monument and Green River, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 136-145, 1970.

04863 **Smith, Clay T.** (compiler). Seventh day road log from Moab, Utah to Albuquerque, New Mexico, via Blanding, Aneth, Four Corners Monument, Farmington, and Cuba, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 155-168, 1970.

Smith, Clay T. *See* Natl. Assoc. Geology Teachers. 04953

Smith, D. B. *See* Summerhayes, C. P. 04902

04600 **Smith, J. Dungan.** Stability of a sand bed subjected to a shear flow of low Froude number: Jour. Geophys. Research, v. 75, no. 30, p. 5928-5940, illus., table, 1970.

The problem of sand bed stability is formulated and solved for a model in which the local slope of the free surface is small relative to the slope of the perturbed lower boundary. The bed is unstable to perturbations of wavelength greater than the wavelengths for which the inertia of the sediment grains is important. Wave speeds and growth rates from numerical calculations are presented and compared with long- and short-wave asymptotic expressions. It is shown that the sand bed instability is due to local accelerations of a shear flow caused by the nonuniform boundary. If either the shear or the acceleration is eliminated from the analysis, the instability cannot be found. On the other hand, no wavelength is defined by such an analysis, and it is shown that the wavelength is determined by spatial adjustments in the turbulent velocity field. — *from* Author's abstract

04645 **Smith, James T.** Ground-water resources of Collingsworth County, Texas: Texas Water Devel. Board Rept. 119, 115 p., illus., tables, geol. map, 1970.

Extensive Permian sediments and Quaternary alluvial deposits crop out in Collingsworth County; principal aquifers are the Permian Blaine Formation, and Quaternary alluvial plain, terrace, and channel deposits. The Blaine yields small to large quantities of saline water to wells and is capable, in places where solution cavities are interconnected, of yielding more than 1,000 gpm; although the water is of poor quality, it is the major source for irrigation. The alluvium yields small to large quantities of water that is generally low in dissolved solids, and is the major source for municipal supply. Water levels have remained generally steady since about 1938, except in a few areas of concentrated pumpage for irrigation. Major quality problems are concentrations of dissolved solids, sulfate, chloride, and sodium. No evidence was found of ground-water pollution from oil-field brines. — *from* Author's abstract

04876 **Smith, Norman D.** The braided stream depositional environment — Comparison of the Platte River with some Silurian clastic rocks, north-central Appalachians: Geol. Soc. America Bull., v. 81, no. 10, p. 2993-3013, illus., tables, 1970.

Study of the South Platte-Platte River in Colorado and Nebraska indicates that braided patterns result mainly from accretion of longitudinal bars and dissection of transverse bars. Bar distribution is dependent on texture of bed load; coarse poorly sorted sediment favors formation of longitudinal bars, and the converse, transverse bars. The relative proportion of transverse bars increases downstream and is accompanied by an increase in the ratio of planar cross-stratification to horizontal stratification. A comparison of the last two features in sandstones and conglomerates of the Lower Shawangunk Conglomerate, Green Pond Conglomerate, and Tuscarora Sandstone in New Jersey and Pennsylvania leads to the conclusion that these formations have similar downslope trends and are braided stream deposits. — Author's abstract

04841 **Smith, Norman E.; Thomas, H. George.** Origins of abnormal fluid pressures [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1791, 1970.

Smith, R. I. *See* Berg, R. B. 04699

04865 **Smith, Roscoe M.** Treasure Hill reinterpreted: Econ. Geology, v. 65, no. 5, p. 538-540, illus., 1970.

Silver-bearing black calcite in veins as much as 3 1/2 feet thick is the primary mineral which was the source of the silver in the near-surface bonanza deposits of cerargyrite mined in 1968-69 on Treasure Hill in White Pine County, Nevada. Downward continuations of the rich ores were never found because the targets of deep-level exploration were steep post-mineral faults which heretofore were interpreted to be ore controls. The veins are in brecciated limestone along gently dipping bedding-plane faults, most prominent of which is at the contact of the Guilmette Limestone with the overlying Pilot Shale. The faults have been eroded from most of the area except across the top of Treasure Hill. Unleached black calcite of ore grade may underlie remnants of Pilot Shale in the surrounding area. — Author's abstract

04909 **Society of Economic Geologists; Weissenborn, A. E.; Armstrong, Frank C.; Fyles, James T.** (editors and chairmen). Lead-zinc deposits in the Kootenay Arc, northeastern Washington and adjacent British Columbia — 1970 Northwest field conference guidebook: Washington Div. Mines and Geology Bull. 61, 123 p., illus., table, 1970.

This area, if parts of Idaho and Montana are included, composes one of the great lead-zinc provinces of the world. Lead-zinc deposits in the carbonate rocks of the Kootenay arc were selected as the scene for the field conference. Ten papers (cited separately) include a general discussion of Mississippi Valley type deposits and specific mines and districts, three in Washington and six in British Columbia. Mississippi Valley, Metaline, and Salmo types of deposits are described briefly in the introduction and their origin discussed. — ESL

Sonett, C. P. *See* Dyal, P. 05107

04986 **Sood, M. K.; Edgar, A. D.** Melting relations of undersaturated alkaline rocks from the Ilímaussaq Intrusion and Grönnedal-Ika Complex, South Greenland, under water vapour and controlled partial oxygen pressure: Medd. Grönland, v. 181, no. 12, 41 p., illus., tables, 1970.

Three samples from the Ilímaussaq Intrusion were put under water vapor pressures up to 2070 bars, and two from the Grönnedal-Ika Complex under controlled oxygen pressures. An initial 1030-bar increment of P-water decreases liquidus temperatures by 240-300°C, and for some alters sequence of crystallization. Decreasing P-oxygen slightly lowers liquidus temperatures, changes primary phase feldspathic minerals to aegirine-rich clinopyroxene. Long melting intervals of agpaitic rocks, at both atmospheric and water vapor pressure, may be due to higher volatile contents of Cl, F, and H_2O than in miaskitic rocks. In a crystallizing alkaline melt these volatiles, in liquid rather than gaseous phase, more or less independently concentrate in sodium-rich minerals. In undersaturated magmas, low P-oxygen conditions may favor miaskitic differentiation, high P-oxygen agpaitic. Laboratory data are in fair agreement with similar field and petrographic observations. — GDC

04985 **Soper, N. J.** A section through the north Peary Land fold belt [abs.]: Geol. Soc. London Proc. 1969, no. 1662, p. 60-62, discussion, 1970.

Sorensen, Fredrick H. *See* Kravitz, Joseph H. 04725

Sorrell, B. J. *See* Tipsword, H. L. 04843

05001 **Spangle, William E.** A city planner's view of education in environmental geology: Jour. Geol. Education, v. 18, no. 5, p. 202-205, 1970.

In educating professionals in the man-environment fields an interprofessional approach is necessary. The author describes a study on the geologic hazards of an area in which geologists and planners collaborated. Planners need a reasonable geologic background, whereas students of environmental geology should also study the social sciences, humanities, governmental processes and urban planning. — EH

04476 **Speed, Robert C.** Gravity anomalies from cavities in salt beds — [Pt.] 1, The surface field, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 367-385, illus., tables, 1970.

The gravity detectability is assessed by comparing maximum anomaly amplitudes as a function of cavity depth, diameter, thickness, and ellipticity with values of precision of measurement and uncertainty of gravity background. The capability for analysis of shape of detectable cavities is assessed by calculations of anomaly elongation for various cavity dimension ratios as a function of depth and thickness of the cavity. Gravity background uncertainties resulting from surface relief of 10 feet or more will mask all signals from cavities deeper than 5000 feet, and increasing surface relief elevates the depth threshold for simple detection of cavities. Only cavities of large volume and ellipticity in the horizontal plane, and at depths less than 2000 feet can be detected. — *from* Author's abstract

Speer, P. R. *See* Cushing, E. M. 04550

Spencer, Samuel A. *See* Lafayette Geological Society. 04752

04626 **Spooner, C. M.; Fairbairn, H. W.** Strontium 87/strontium 86 initial ratios in pyroxene granulite terranes: Jour. Geophys. Research, v. 75, no. 32, p. 6706-6713, illus., tables, 1970.

Rb-Sr isotopic analyses of granulite facies rocks from East Africa, India, Guyana, the Adirondacks (New York), and southeastern Ontario give regression plots that restrict initial Sr-87/Sr-86 to a narrow range 0.700-0.707, comparable with anorthosite and continental basalt. The ratios agree with published values for granulite from India, Scotland, and Ivory Coast. Both geophysical and geochemical evidence suggest that these rocks developed in the lower crust and that most of the examples investigated were of igneous origin. Although subsequent regional metamorphism at the granulite facies level may have rearranged the assemblages, initial Sr-87/Sr-86 has been unaffected. — Authors' abstract

Spooner, C. M. *See* Brookins, D. G. 05017

04628 **Sprenkel-Segel, E. L.** Recoilless resonance spectroscopy of meteoritic iron oxides: Jour. Geophys. Research, v. 75, no. 32, p. 6618-6630, illus., tables, 1970.

Recoilless resonance spectra taken at 80° and 300°K were used to identify oxidation products in meteorites. Wolf Creek (a completely oxidized iron) contains (in order of decreasing abundance) αFeOOH, βFeOOH, γFe_2O_3, Fe_3O_4, and γFeOOH. The dark chondrite fragments in the Cumberland Falls achondrite have spectra containing mainly βFeOOH. The unequilibrated ordinary chondrite Clovis (no. 1) has γFeOOH as the chief oxidation product. Absorption spectra should be recorded at several temperatures to avoid ambiguities due to presence of superparamagnetic ultrafine iron oxide particles. Comparison of Mössbauer spectra of the Cumberland Falls dark portion with recent chemical analyses demonstrates that it is not possible to correctly apportion iron among the metal, sulfide, and silicate phases without knowing the ferric iron content, which can be determined only by resonance spectroscopy. — *from* Author's abstract

Steinhilber, W. L. *See* Hershey, H. G. 04930

Stephenson, G. R. *See* England, C. B. 05005

04591 **Sterling, David A.; Malan, Roger C.** Distribution of uranium and thorium in Precambrian rocks of the southwestern United States: Soc. Mining Engineers AIME Trans., v. 247, no. 3, p. 255-259, illus., table, 1970.

The Atomic Energy Commission is investigating the distribution of uranium and thorium in the Precambrian of the western United States and the relationship of time-space-facies patterns of uranium and thorium enrichment in the Precambrian to the major resources of uranium in Mesozoic and Cenozoic continental clastic sediments. The results of preliminary studies in the southwestern United States are summarized. — Authors' abstract

Stevens, R. D. *See* Boyle, R. W. 05076

04988 **Stewart, J. W.** Precambrian alkaline-ultramafic/carbonatite volcanism at Qagssiarssuk, South Greenland: Medd. Grönland, v. 181, no. 4, 70 p., illus., tables, geol. maps, 1970; *reprinted as* Grönlands Geol. Undersögelse Bull. 84, 1970.

From an early Gardar outburst (c. 1300 m.y.), high-level volcanic structures at Qagssiarssuk include remnants of pyroclastic cones and uppermost parts of diatremes; not all penetrated to the surface. Many features recall carbonatite volcanoes of East Africa and Zambia. Faulting and subsequent erosion exposed crystalline basement penetrated by tuffsite diatremes and other minor intrusions comagmatic with flows, but half a kilometer deeper. The igneous rock types belong to three main groups: lamprophyres, melilite-rock, and mica-pyroxenite. Concealed car-

bonatite is indicated by blocks of sövite, and other material, in pyroclastics. Carbonatization was first calcitic, then ankeritic; that of melilite-rock was particularly intense. Barite and fluorite were also introduced, and, with an abundance of volatiles, it is probable that fluidized systems were developed. In the adjacent granitic basement, progressive potash feldspathization was nearly complete. — GDC

04873 **Stoiber, Richard E.; Rose, William I., Jr.** The geochemistry of Central American volcanic gas condensates: Geol. Soc. America Bull., v. 81, no. 10, p. 2891-2911, illus., tables, 1970.

Chemical data on exhalations from high temperature (150°C+) fumaroles were obtained from 132 gas condensates collected over a 5-year period from 6 Central American volcanoes. All condensates were collected within 500 meters of an active volcanic vent. Variations in gas composition of a fumarole depends on fumarole location, and time of collection relative to volcanic cycle. Fumaroles on flows are Cl-rich, those at central vents have high SO_4, the Cl/SO_4 ratio decreases before an eruptive period and rises afterward. Chlorine and fluorine concentrations and Cl/F are time and temperature dependent, probably due to increased ground water dilution, loss of chlorine from magmatic source and wall rock reaction. The alkalis come from the wall rocks as well as the magma. Systematic monitoring of condensates at fumaroles should enable prediction of eruptive periods months in advance.

04642 **Storey, Taras P.** Evaporite basin configuration — Structural versus sedimentary interpretation, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 8-19, illus., 1970.

Three very extensive subsurface Devonian evaporite basins in Alberta are: (1) oldest, which includes three major salt sequences and other strata in the Lower Elk Point Group; (2) younger and most extensive, characterized by the Muskeg Formation of the Upper Elk Point; the Elk Point is also represented by the Prairie Evaporite Formation in Saskatchewan, Manitoba, Montana, and North Dakota; and (3) youngest and least extensive, represented by Stettler Formation of the Wabumum Group. Basin profiles are shown to be structural remnants of originally much vaster areas of evaporite deposition. Within the evaporite sequences wide-ranging thin marker horizons of shale and carbonate display the natural stratigraphic succession; the uniform thickness of each successive bed points against differential sedimentary tectonics. — *from* Author's abstract

04499 **Stout, George H.; Jensen, Lyle H.** X-ray structure determination — A practical guide: New York, Macmillan Co., 467 p., illus., tables, 1970.

This book examines practical problems met by those who use X-ray crystallography as a structural tool. The text is divided into three parts: preliminary stages, phase problem, and refinement and results. — MCM

Strabala, J. M. *See* Caldwell, John W. 04473

Strezhneva, K. M. *See* Troitskiy, V. S. 05096

04936 **Stuckey, Jasper L.** Mineral industry of North Carolina from 1960 through 1967: North Carolina Div. Mineral Resources Econ. Paper 68, 25 p., illus., tables, 1970.

Although this is primarily a review of mineral production in North Carolina, for each commodity a brief account is given of the occurrence of metallic minerals, nonmetallic minerals and rocks, and mineral fuels. — MCM

04842 **Stude, Gerald R.** Application of paleobathymetry in exploration [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1791, 1970.

05120 **Stuiver, Minze.** Tree ring, varve and carbon-14 chronologies: Nature, v. 228, no. 5270, p. 454-455, illus., 1970.

The time span of tree ring chronology, at present 7,400 years, is unlikely to be extended much more, but varve series seem a suitable alternative for the extension of the study of carbon-14 variations. Results of C-14 measurements of the classic Swedish varve chronology and of a series from Lake of the Clouds, Minnesota, are available at present. The agreement between tree ring and Lake of the Clouds varve series is excellent over a 7,400-year interval. Agreement is lacking between the two varve chronologies before 7,000 yr B.P., which may be due to errors in either or both series. In general, C-14 dates corresponding with 5,000-7,400 solar years will be 600 to 800 years too young; if the Lake of the Clouds chronology is accepted, a similar error is also indicated for the 7,400-10,000 varve-year interval, whereas the Swedish varve chronology indicates little deviation between C-14 and varve dates for 8,000-12,000 years. — DBV

Stumpfl, E. F. *See* Halls, Chris. 04647

Suess, Erwin. *See* Chave, Keith E. 04616

04732 **Suess, Steven T.** Some effects of gravitational tides on a model earth's core: Jour. Geophys. Research, v. 75, no. 32, p. 6650-6661, illus., table, 1970.

A simple two-density earth model, with no dissipation and a point Moon, is examined for the net effects of lunar tides and precession on the dynamics of the fluid core. The problem is discussed in terms of the fundamental parameters of the system, which determine the tidal configuration and the precession rate. The resultant fluid flow is generally nontrivial, and has been shown by other experimental and theoretical studies to drive geophysically significant interior deviations from constant vorticity. Criteria are deduced that show when the tides can cancel precessional effects, a case not existing in the Earth. Because of the elementary nature of the model, the problem remains completely analytic, although it is thus limited in its relation to the Earth. — Author's abstract

04902 **Summerhayes, C. P.; Hazelhoff-Roelfzema, B. H.; Tooms, J. S.; Smith, D. B.** Phosphorite prospecting using a submersible scintillation counter: Econ. Geology, v. 65, no. 6, p. 718-723, illus., table, 1970.

Following successful experiments demonstrating that radioactivity measurements on samples can be used as a guide to their phosphate content, preliminary trials have been made on the application of a submersible scintillation counter as a prospecting tool. The results have been sufficiently encouraging to warrant the development of towed continuously recording equipment. — Authors' abstract

04950 **Sutton, Robert G.; Bowen, Zeddie P.; McAlester, A. Lee.** Marine shelf environments of the Upper Devonian Sonyea Group of New York: Geol. Soc. America Bull., v. 81, no. 10, p. 2975-2992, illus., tables, 1970.

A sedimentologic and paleontologic study of the Sonyea Group has led to a reconstruction of the environmental history of the marine shelf of the Catskill Delta. By comparing the Sonyea sedimentary patterns with present-day deltas, the following environments have been recognized: open shelf, prodelta, delta platform, delta front sands, distributary mouth bars, channels, estuaries, and marshes. Each is characterized by distinctive patterns of fossil abundance and diversity. Fossils are relatively scarce in environments located in the nearshore and outermost parts of the shelf. In the prodelta, delta front sand, and delta platform environments, an abundant shelly benthonic fauna dominated by brachiopods and bivalve mollusks flourished. Four distinctive fossil associations are present and are believed to represent the preserved remains of four benthonic communities adapted to differing dynamic conditions within the prograding deltaic sediments. — *from* Authors' abstract

04724 **Swift, Donald J. P.; Shideler, Gerald L.; Avignone, Nicholas F.; Holliday, Barry W.; Dill, Charles E., Jr.** Quaternary sedimentation on the inner Atlantic shelf between Cape Henry and Cape Hatteras — A preliminary report: Maritime Sediments, v. 6, no. 1, p. 5-11, illus., 1970.

A study of coastal features and their genesis was made along the Cape Hatteras to Cape Henry sector of the inner Atlantic shelf in North Carolina and Virginia. Beach and bottom samples were taken along a series of transects. Preliminary results of grain-size and heavy-mineral analyses are given. From a resurvey of the False Cape area the retreats and advances of the ridge system are noted. Studies of bottom clay and of core samples reveal that the False Cape ridges parallel beach ridges of the Sandbridge Formation, ascribed to the late Sangamon regression, but are probably maintained by the modern hydraulic regime. — EH

Swindale, L. D. *See* Hussain, M. S. 05124

Syers, J. K. *See* Dolcater, D. L. 04674

04689 **Sykes, Lynn R.** Focal mechanism solutions for earthquakes along the world rift system: Seismol. Soc. America Bull., v. 60, no. 5, p. 1749-1752, illus., table, 1970.

This paper presents the 13 focal mechanism solutions on which two earlier papers (1967, 1968) were based, so that their reliability can be judged by those interested. The tectonic implications are not discussed as they were covered in the earlier papers. — DBV

04729 **Sykes, Lynn R.** Earthquake swarms and sea-floor spreading: Jour. Geophys. Research, v. 75, no. 32, p. 6598-6611, illus., 1970.

More than 20 earthquake swarms from the Mid-Atlantic Ridge and other parts of the mid-ocean ridge system during the past ten years appear to be related to tectonic, magmatic, or hydrothermal processes near ridge crests. Most of the larger earthquakes associated with the ridge system occur along fracture zones, and their mechanisms are characterized by a predominance of strike-slip faulting. Nearly all the earthquake swarms are restricted to the ridge crests. Earthquakes on ridge crests are characterized by a large component of normal faulting, and many of the swarms may have a similar mechanism. This study increases the number of regions for which earthquake swarms are associated with areas of historic or recent volcanism; it also suggests a close connection between the two phenomena. Earthquake swarms may offer a means of detecting volcanic, hydrothermal, or magmatic processes in progress in submarine areas. — *from* Author's abstract

Symons, D. T. A. *See* Schwarz, E. J. 04621

05119 **Szuwalski, Andre.** Littoral Environment Observation Program in California — Prelim. Rept., February-December 1968: U.S. Army Corps Engineers Coastal Eng. Research Center Misc. Paper 2-70, [242] p., illus., tables, 1970.

The purpose of LEO program of California and the Corps of Engineers was to collect data for analyzing littoral processes and physical characteristics of the California shore. The littoral variables collected include the following beach characteristics: foreshore slope, width and elevation of berm, presence of cusps, and samples of sediments analyzed for mean and median diameter, standard deviation, skewness, and kurtosis. State of the sea variables include tide level; wave height, period, and direction; type of breaker; direction and velocity of littoral currents; presence of rip currents; and water temperature. Wind velocity and direction are recorded, and panoramic photographs obtained. The objective is to establish a bank of repetitive, systematic measurements of meteorological and oceanographic forces affecting the shoreline and its response to them. — *from* Author's abstract

04496 **Tanner, Hans.** (editor). The complete guide to rocks, gems and minerals: Los Angeles, Calif., Peterson Publishing Co., 88 p., illus., 1970.

Sections of this popular account are: moon rocks, fluorescent minerals, gold, introduction to the hobby, collecting, field recognition, micromounts, crown jewels of Iran, new mineral locations, mineral recognition, and directory. — MCM

04688 **Tarr, Arthur C.** New maps of polar seismicity: Seismol. Soc. America Bull., v. 60, no. 5, p. 1745-1747, illus., 1970.

Epicenters from the PDE file of the Coast and Geodetic Survey for the time period January 1, 1961 to September 30, 1969, have been plotted to portray the high latitudes (45°-90°) of the northern and southern hemisphere. Three figures depict epicenters of 0- to 70-km focal depth shocks in the northern and southern hemispheres and of 71- to 300-km focal depth shocks in the northern hemisphere. The accuracy of the epicenters with respect to the polar grid is limited mainly by the stability of the chart paper on the plotter drum and by the fineness of the thinning grid in a computer subprogram which eliminates overplotting; registration error from these two sources is less than 0.2° and hence scarcely visible. The uncertainty associated with epicenters located by few stations that are badly distributed azimuthally is usually the principal source of scatter; thus discretion must be used in interpreting seismicity patterns in remote areas. — DBV

04571 **Tasch, Paul.** Biochemical and geochemical aspects of the White Salt Pan, Bonaire, Netherlands Antilles, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 204-210, illus., 1970.

About 75 mm of evaporite has encrusted a Cenozoic reefal (?) limestone in the area adjacent to Pekelmeer. The upper third is halite hopper crystals and the lower two thirds is dominantly gypsum with associated halite hoppers. A probable diurnal banding is evident in the hopper crystals. Mg-bearing crystals are present in the lower portion of the section, showing the mobility of the Mg cations in 200 years, the age of the basin. The same kind of organic material was trapped in the halite hopper and subsurface crystals and this Caribbean saltpan may serve as an analog of biochemical significance for the study of ancient salt deposits. For example, four to five of the same amino acids reported in the Upper Silurian rock salt from New York State were found in the Bonaire mixed evaporite (glycine, alanine, tyrosine, glutamic acid, and possibly serine). — *from* Author's abstract

04740 **Tate, Donald M.** The drainage evolution of the Kawartha Lakes district, Ontario [abs.]: Ontario Geography, no. 5, p. 88-89, 1970.

04989 **Tedrow, J. C. F.** Soil investigations in Inglefield Land, Greenland: Medd. Grönland, v. 188, no. 3, 93 p., illus., tables, 1970.

In this high arctic desert area of northwestern Greenland, Archean basement is capped by Paleozoic sedimentary rocks with a few diabase intrusions. Narrow wet swales and meadows are covered with a vegetative mat, and there is evidence of three glaciations, the earliest probably reaching Rensselaer Buyt. An organic layer within a fluvioglacial terrace is C-14 dated at 20,800 yr. B.P. Six generic soils or soil conditions are recognized: Polar Desert, Arctic Brown, Tundra, Hummocky Ground, Polar Desert-Tundra interjacence, and bedrock and boulder fields. Mechanical, mineralogical, and chemical analyses of the soils are given. Desert pavement and secondary carbonates are extensive in well-drained sites; salts effloresce in certain soils in rainless periods. Many soil grains show allogenic coatings, some feldspars are slightly altered, but for the most part, minerals appear fresh. Some iron-stained aggregates have formed in the Polar Desert soils. — GDC

Tek, M. Rasin. *See* Katz, Donald L. 05064

05075 **Templeman-Kluit, D. J.** Sulphur isotopic investigations of the lead-zinc-silver-cadmium deposits of the Keno Hill-Galena Hill area, Yukon, Canada [discussion of paper by R. W. Boyle; R. K. Wanless; R. D. Stevens, 1970]: Econ. Geology, v. 65, no. 6, p. 731, 1970.

For original paper, *see* ibid., no. 1, p. 1-10, 1970; Abs. North American Geology, February 1971.

04471 **Terzaghi, Ruth D.** Brinefield subsidence at Windsor, Ontario, *in* Third symposium on salt, V. 2 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 298-307, illus., 1970.

Eighty-five reference elevations were established after slight subsidence in 1948, and measured annually thereafter. A shallow bowl was recognized which had settled 2.5

inches the first year; it was over 16 inches deep in 1954 when rapid subsidence occurred resulting in a depression 500 feet in diameter and 25 feet deep. Subsequent investigations indicated that sudden important subsidence was the culminating event in a progressive failure of strata overlying a solution cavity produced by brine extraction from salt deposits located at depths below 1000 feet. — *from* Author's abstract

04789 **Texas Planning Agency Council.** (Water Oriented Data Programs Sec. of Interagency Nat. Resources Council, compiler). Catalog of water oriented data (available from eight Texas state agencies) — V. 1, Canadian River basin: Austin, Tex., Texas Water Devel. Board, 29 p., illus., tables, 1970.

Of the 24 volumes in the catalog, 23 contain data for individual river or coastal basins; volume 24 contains data for bays and estuaries. The catalog contains information about water data acquisition activities of various Texas agencies, but does not give actual data; rather it will enable interested parties to determine what data are available and where they can be obtained. Chapter headings are: water quantity, water quality, supplementary water data, and water control facilities. — MCM

04890 **Thom, Bruce G.** Carolina Bays — Reply [to discussion of 'Carolina Bays in Horry and Marion Counties, South Carolina' by C. W. Cooke, 1970]: Geol. Soc. America Bull., v. 81, no. 10, p. 3173-3174, 1970.

For the paper under discussion *see* ibid., v. 81, no. 3, p. 783-813, 1970; Abs. North American Geology, September 1970.

Thomas, Chester E., Jr. *See* Ryder, Robert B. 04536

Thomas, H. George. *See* Smith, Norman E. 04841

Thomas, Mendall P. *See* Ryder, Robert B. 04536

Thomlinson, Catherine. *See* Berner, Robert A. 04679

04522 **Thompson, Alan Bruce.** Laumontite equilibria and the zeolite facies: Am. Jour. Sci., v. 269, no. 3, p. 267-275, illus., 1970.

The reaction laumontite = anorthite + 2 quartz + $4H_2O$ has been studied using a rate reaction method utilizing the weight-change of a single crystal of quartz. The data suggest equilibrium at 310 ± 10°C at 1 kb, 317 ± 10°C at 2 kb, 338 ± 10°C at 4 kb, and 347 ± 10°C at 6 kb. The intersection in P-T space of the slope of this reaction with that of the slope for the reaction lawsonite = anorthite + $2H_2O$ is an invariant point through which the slope for the reaction laumontite = lawsonite + 2 quartz + $2H_2O$ passes. Data from the present study suggest that this reaction approaches equilibrium at 2.75 ± 0.25 kb at 250°C. The data from these equilibria give useful limiting data on the stability of the zeolite facies. — *from* Author's abstract

Thoms, Robert L. *See* Martinez, Joseph D. 05030

Tilak, S. T. *See* Agashe, Shripad N. 04794

04843 **Tipsword, H. L.; Fowler, W. A., Jr.; Sorrell, B. J.** Future petroleum provinces of United States western gulf basin, lower Miocene-Oligocene [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1791-1792, 1970.

Tooms, J. S. *See* Summerhayes, C. P. 04902

04505 **Tozer, D. C.** Temperature, conductivity, composition and heat flow, *in* Symposium on multidisciplinary studies of unusual regions of the upper mantle, Madrid, Spain, 1969, Proc.: Jour. Geomagnetism and Geoelectricity, v. 22, nos. 1-2, p. 35-51, illus., 1970.

This paper reviews the interpretive theory of the electrical conductivity distribution in the mantle as inferred from geomagnetic variations. The laboratory measurements

of the electrical conductivity in relevant materials [fayalite, forsterite, basic and ultrabasic rock, olivine, etc.] are discussed, and their implications for estimates of the average radial temperature distribution are explored. New developments in geothermal calculations using convection theory are described since they appear to be the most promising means of interpreting the regions of anomalous electrical conductivity well within the upper mantle. The same convection theory applied to the Moon clarifies the recent observations of a very short Cowling time for this body. — Author's abstract

04617 **Traill, R. J.** A catalogue of Canadian minerals: Canada Geol. Survey Paper 69-45, 649 p., 1970.

Minerals are listed in alphabetical order and for each mineral the localities of occurrence are subdivided according to province or territory in alphabetical order and in increasing numerical order of the NTS system. Each entry consists of the NTS number, normally equivalent to a 1:50,000 map sheet reference; a more detailed description of the location; a brief account of the information pertinent to the mineral found at that locality; and a reference to the source of information. Physical and optical properties and detailed mineral descriptions are not given; chemical analyses have been reported and related to geographic location where possible. X-ray powder diffraction data are listed for each mineral species. — *from* Author's introduction

05090 **Trask, N. J.** Ranger photographs of the Moon, *in* Symposium on planetary atmospheres and surfaces, Woods Hole, Mass., 1969: Radio Sci., v. 5, no. 2, p. 123-128, illus., 1970.

Photographs from the Ranger probes provided the first direct evidence on the fine-scale topography of the Moon and showed that the surface is relatively smooth over slope distances of 1 meter. In addition to craters, elements contributing to the topography at this scale are the closely spaced ridges and troughs of lunar patterned ground. Blocks in the size range 0.5 meters to several meters were not seen in the Ranger pictures, perhaps because of the limited sampling at three widely separated points. Ranger 7 photographs showed the preponderance of shallow elongate to circular craters along rays. Ranger 8 photographs were notable for portraying with new clarity the craters Sabine and Ritter, which appear to be of internal rather than impact origin. Ranger 9 photographs of the floor of the crater Alphonsus contained data from which a complicated geologic history of the floor can be deciphered. — Author's abstract

Trembath, L. T. *See* Ghosh-Dastidar, P. 04487

05096 **Troitskiy, V. S.; Bondar', L. N.; Zelinskaya, M. R.; Strezhneva, K. M.** Comparison of the chemical composition of lunar surface material determined by radioastronomical observations with the results of chemical analysis obtained by Surveyor, *in* Symposium on planetary atmospheres and surfaces, Woods Hole, Mass., 1969: Radio Sci., v. 5, no. 2, p. 247-251, illus., 1970.

Radar measurements provide the reflection coefficient and some limited data on the nature of the lunar material. The loss angle in dielectrics, dependent on the nature of the materials, may be used to help identify lunar materials by comparing loss angle values to those found for terrestrial rocks. A method described here shows promise for the lunar and Martian surfaces. — JHF

04686 **Tsai, N. C.; Housner, G. W.** Calculation of surface motions of a layered half-space: Seismol. Soc. America Bull., v. 60, no. 5, p. 1625-1651, illus., tables, 1970.

A new method is presented for computing the transient response of a set of horizontally stratified, linearly elastic layers overlying a uniform half-space and excited by vertically incident, transient plane waves. In addition, a simple approximate method of satisfactory accuracy is developed that reduces the computing time required. Calculated responses are compared with motions recorded under Union Bay in Seattle to evaluate the agreement between recorded and calculated motions. — Authors' abstract

04803 **Turcan, A. N., Jr.; Winslow, A. G.** Quantitative mapping of salinity, volume, and yield of saline aquifers using borehole geophysical logs, *in* Saline water symposium: Water Resources Research, v. 6, no. 5, p. 1478-1481, illus., 1970.

Techniques that permit quick, practical, and satisfactory evaluation of electrical logs were developed to estimate volume and distribution of saline water in aquifers in Louisiana. Of about 200,000 available electrical and induction-electrical logs, about 1,000 representative logs were selected for detailed analysis. An empirical relation, called the field formation resistivity factor, was determined as the ratio of formation resistivity to water resistivity corrected to 25°C, and used to estimate the altitude of ground-water salinity interfaces of 1,000, 3,000, and 10,000 mg/l of dissolved solids. Average coefficients of permeability values and bed thickness information were used to determine coefficients of transmissibility. Using theoretical and standard conditions of well design, yield, and aquifer thickness, well yields were computed. This permitted areal comparison of yield from each of the saline zones. — *from* Authors' abstract

Turkevich, Anthony L. *See* Patterson, James H. 05094

05050 **Tychsen, Paul C.** "Firsts" in the geological record, [Chap.] 8 *in* Rock strata and the Bible record (P. A. Zimmerman, editor): St. Louis, Mo., and London, England, Concordia Publishing House, p. 124-132, 1970.

Specific groups of plants and animals tend to succeed one another in the geological record in a fairly definite and determinable order, each period being recognized and identified by its own particular group of fossils. The first appearances and extinctions of fauna and flora are summarized for the geologic time chart. Future fossil finds may, in some instances, further confirm existing information as to positioning of "firsts" and in other instances may show need to change the position. – MCM

05052 **Tychsen, Paul C.** Geology and the flood, [Chap.] 11 *in* Rock strata and the Bible record (P. A. Zimmerman, editor): St. Louis, Mo., and London, England, Concordia Publishing House, p. 193-200, 1970.

From the geologic record, specific periods of geologic time were characterized by extensive floods which covered considerable portions of entire continents. The traditional Biblical date for the Flood, about 4,300 yr B.P., is subject to criticism. If one attempts to pinpoint the occurrence by correlating it with commonly accepted conclusions of geology, the Flood would be confined to waning stages of the Pleistocene or beginnings of the Holocene. Fairbridge (1960) indicated a marked rise in sea level about 6,000 yr B.P.; if the water remained on the Earth's surface for only about a year, little evidence, if any, would be left. However, it is not possible to identify any great floods of the past with Noah's flood; it would seem best to allow the Deluge to be a concern of theologians. — MCM

Uchupi, Elazar. *See* Ballard, Robert D. 04490

04745 **Uchupi, Elazar; Phillips, J. D.; Prada, K. E.** Origin and structure of the New England Seamount Chain: Deep-Sea Research, v. 17, no. 3, p. 483-494, illus., 1970.

The New England Seamount Chain is located along a fracture zone formed by a discontinuity in sea-floor spreading pattern. This discontinuity resulted from either a simple transform fault which opened progressively along its length as it was formed, or the entire fault line opened at one time due to a later change in spreading direction. The opening of the fault may have been initiated during earliest Mesozoic and probably continued to the Cretaceous. Differences in rates and/or duration of spreading on either side of the fault may have caused the offset of a previous continuous basin and ridge system beneath the shelf. — Authors' abstract

04755 **Uhrenholdt, Soren.** Bayou White Field, Pointe Coupee Parish, Louisiana, *in* Typical oil and gas fields of southwestern Louisiana, V. 2: Lafayette, La., Lafayette Geol. Soc., p. 3-3d, illus., 1970.

Updegrove, W. S. *See* Oro, J. 05088

04850 **Updike, R. G.; Péwé, T. L.** The glacial and related Quaternary events of the San Francisco Peaks, Arizona, *in* Guidebook to Four Corners, Colorado Plateau, central Rocky Mountain region — Natl. Assoc. Geology Teachers, Southwest Sec., Field Conf. Earth Sci., Cedar City, Utah, 1970: Socorro, N. Mex., New Mexico Inst. Mining and Technology, p. 39-42, illus., 1970.

The San Francisco Peaks are eroded remnants of one of the highest composite volcanic cones in the southwest, and provide one of the most significant late Tertiary and Quaternary sequences. A Pliocene age is favored for the initial eruptions, followed by a cycle of valley cutting. The Sinagua Formation occurs as large fans, and its deposition postdates eruption of North Sugarloaf Mtn. between 2-4 m.y. ago. Ash from another eruption, 530,000 y. B.P., overlies the Sinagua. The first glaciation, Sugarloaf, postdates all of these, and remnants remain which have been assigned an Illinoisan age. After a period of erosion, the climate became colder and deposits of the early Wisconsin Core Ridge glaciation were laid down. Late Wisconsin Snowslide Spring glaciation formed only valley glaciers. Holocene periglacial deposits formed high on the peaks; two stages of activity are apparent. — ESL

Updike, Randall G. *See* Péwé, Troy L. 05011

04652 **U.S. Geological Survey.** Bibliography of North American geology, 1967: U.S. Geol. Survey Bull. 1267, 1029 p., 1970.

04589 **U.S. Natl. Aeronaut. and Space Adm.** Remote sensing of earth resources, a literature survey with indexes — NASA SP-7036: Springfield, Va., Clearinghous Federal Sci. and Tech. Inf., 1276 p., 1970.

Valentine, James W. *See* Lipps, Jere H. 04927

05019 **VanDiver, Bradford B.; Rabson, Gustave.** Modal analysis of closed banded structures by radial point counting: Jour. Geology, v. 78, no. 5, p. 589-596, illus., table, 1970.

A circular adapter plate permits point-count traverses at a regular series of azimuths from a chosen point in the thin section, such as the apparent center of a concentric structure (spherulite, concretion, orbicule, etc.). Relative volumetric proportions of mineral species in the successive bands can be expressed graphically. Over-all modal composition obtained in this manner does not differ significantly from the result obtained by conventional rectangular-grid point counting. — REW

04899 **VanDorn, William G.** Tsunami response at Wake Island, a model study: Jour. Marine Research, v. 28, no. 3, p. 336-344, illus., 1970.

The amplitude response to periodic plane waves incident upon an undisturbed model of Wake Island on a scale of 57,500:1 was determined for a number of frequencies covering the long-wave portion of the wave spectrum and from three different directions. For wave lengths long compared with the *effective* circumference of the island — defined as that contour about which the long-wave traveltime is a minimum — the response is essentially unity and is independent of position around the island. For relatively short waves, the response is irregular but is generally much greater than unity. These results are consistent with the well-known behavior of sound waves scattered from circular cylinders. It is concluded that small isolated islands are probably good observation platforms for the low-frequency waves characteristic of destructive tsunamis but that substantial spectral modification occurs for the dispersive phase. At Wake Island, the shortest unperturbed period is about 10 min. — Author's abstract

VanVoorhis, Gerald D. *See* Hohmann, Gerald W. 04785

05026 **Vastano, A. C.; Reid R. O.** Tsunami response at Wake Island — Comparison of the hydraulic and numerical approaches: Jour. Marine Research, v. 28, no. 3, p. 345-356, illus., 1970.

A comparison is made between two different methods of estimating, at an island, the water-level response associated with incident plane gravity waves of periods characteristic of tsunamis. VanDorn (ibid., p. 336-344) has investigated, by means of a laboratory model on an undistorted scale, the amplitude response versus the period and azimuth for Wake Island. In this paper a mathematical model based on a matching numerical integration of the linearized long-wave equations is employed for bathymetry and wave input, duplicating as nearly as possible that of the hydraulic model. Calculations were made for a discrete grid based on an orthogonal "island coordinate" system that facilitates the application of boundary conditions at the island, and in the far field. A favorable comparison exists between the results of the two models; the numerical system has a high degree of resolution that verifies details of the response patterns indicated by the hydraulic model. — Authors' abstract

Vernon, Robert O. *See* García-Bengochea, José I. 04808

04844 **Vernon, Roger C.** Possible future petroleum provinces of United States western gulf basin, pre-Jurassic [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1792-1793, 1970.

Verville, G. J. *See* Sanderson, G. A. 04701

05116 **Vinogradov, A. P.** K proiskhozhdeniyu lunnykh porod [On the origin of the lunar rocks (with English summ.)]: Geokhimiya, no. 1, p. 3-14, tables, 1970.

The origin of the surface rocks of the Moon is considered in the light of Apollo-11 data on lunar rock composition. These rocks were melted from the interior of the Moon, and crystallized from a silicate melt. Thus the Moon must be inhomogeneous. Most of the lunar rocks have the composition of eucrites (feldspar achondrites). The probability of the existence of the metallic phase is calculated to be low; in this connection the problem of the mesosiderites is of great interest. The most probable source of lunar matter may have been chondrites with high concentrations of iron silicate and no metallic phase. The possibility of falls of Ca-feldspar achondrites on Earth cannot be ruled out. — DBV

Visman, J. *See* Walsh, J. H. 04561

05104 **Wade, L. C.** Photographic summary of the Apollo 12 mission, *in* Apollo 12 preliminary science report: U.S. Natl. Aeronautics and Space Adm. Spec. Pub. SP-235, p. 7-27, illus., 1970.

Thirty-six historic photographs, with explanatory text, are given in illustration of the Apollo 12 mission. — JHF

Wadell, James S. *See* Royse, Chester F. 04954

04655 **Wagner, W. Philip.** Pleistocene mountain glaciation, northern Vermont: Geol. Soc. America Bull., v. 81, no. 8, p. 2465-2469, illus., 1970.

Lateral moraines, end moraines, cirques, and outwash plains together demonstrate the former presence of local valley glaciers in the Green Mountains of northern Vermont. Two phases of valley glaciation are recognized. The earliest phase is represented by end moraines and stagnant ice features that are graded to outwash plains that in turn can be traced into deltas of Laurentide proglacial lakes. Comparison of delta elevations indicates that the moraines of the earliest phase are generally the same age but with minor differences. The second phase is indicated by cirque moraines and outwash plains. The earlier phase is definitely late Woodfordian, but the absolute age of the later phase is uncertain. Although valley glaciers are recognized, the possibility of an ice cap in northern Vermont is considered unlikely. — Author's abstract

Wahl, K. D. *See* Hershey, H. G. 04930

04942 **Walker, J. R.; Massingill, J. V.** Slump features on the Mississippi Fan, northeastern Gulf of Mexico: Geol. Soc. America Bull., v. 81, no. 10, p. 3101-3108, illus., 1970.

During recent geologic time, the Mississippi River has been the major contributor of sediment to the Gulf basin. A mass of sediments has been produced on the continental slope seaward of the mouth of this system. This feature has been called the Mississippi Fan. On a recent geophysical cruise in the Gulf of Mexico, crossings of the fan resulted in the conclusion that large slumps were active recently. Evidence indicates that one movement started near the Mississippi Trough and moved 160 nm toward the southeast. Part of this slope flowed south and southwest, or a second developed at the same time and flowed in this direction for 130 nm. The southeasterly slump is 70 nm wide and the one to the west is 38 nm wide. The maximum measured vertical distance from the origin of these to the downslope limit is 4000 feet. — *from* Authors' abstract

Walker, John L. *See* Bradshaw, Peter M. D. 04663

Walker, John L. *See* Bradshaw, Peter M. D. 04672

04716 **Walker, Kenneth R.; LaPorte, Léo F.** Congruent fossil communities from Ordovician and Devonian carbonates of New York: Jour. Paleontology, v. 44, no. 5, p. 928-944, illus., tables, 1970.

Comparison of the shallow water, marine carbonate rocks of the Black River Group (Ordovician) and Manlius Formation (Devonian) show strong similarities in lithofacies and biofacies. The lithologic resemblances record similar sedimentologic responses to slow epeiric transgression; the parallelism of the fossil assemblages at high taxonomic levels reflects ecologic control of major adaptive types. This study shows fossil assemblages as evolving communities rather than isolated aggregations. Four fossil communities, named in terms of inferred depositional environments, are recognized in both the Black River and the Manlius: supratidal, high intertidal, low intertidal, and subtidal. — *from* Authors' abstract

04872 **Wallace, Robert E.** Earthquake recurrence intervals on the San Andreas fault: Geol. Soc. America Bull., v. 81, no. 10, p. 2875-2889, illus., 1970.

Possible recurrence intervals between earthquakes of different magnitude are derived by relating long-term offset rates since mid-Tertiary time, displacements, and lengths of breaks recorded for historic earthquakes, and tectonic creep rates. Tectonic creep is believed to be inversely related to Richter magnitude. — AG

04972 **Wallis, R. H.** The geology of the Dufferin Lake area (west half), Saskatchewan: Saskatchewan Dept. Mineral Resources Rept. 132, 60 p., illus., tables, geol. map, 1970.

Hozirontally bedded orthoquartzites and pebble layers of the mid-Proterozoic(?) Athabasca Formation unconformably overlie northeast-striking metamorphic rocks in this glaciated area. The basement rocks, eleven distinguished units including the Virgin Schist Group, have undergone a complex sequence of deformation and metamorphism, with three different sets of folds; later metadiabase dikes strike northeast along a center zone. A wide mylonite belt across this sequence, with an 8-mi dextral offset, is offset sinistrally by later faulting. Recrystallization produced a sequence of mineral assemblages; a granulite facies lies west of the mylonite belt, but the Virgin Schist Group and rocks to east are a low pressure amphibolite facies. Intensively explored, low-grade mineralization of polymetallic sulfides and magnetite is associated with the Virgin Schist Group. — GDC

04561 **Walsh, J. H.; Visman, J.; Whalley, B. J. P.; Ahmed, S. M.** Removal of pyrite from Cape Breton coals destined for use in metallurgical processes, *in* Mineral processing and extractive metallurgy — Commonwealth Mining and Metall. Cong., 9th, 1969, Proc., V. 3: London, Inst. Mining and Metallurgy, p. 143-177, illus., tables, 1970.

Ash content of these coals is not excessive, but sulfur content is high and variable. A laboratory float-sink technique was used to study distribution of pyrite in the coals, both from sample to sample and in the different size ranges in which liberation could be expected. Nearly all the sulfur variation was found to be due to changes in pyrite content (or its decomposition products) — about one-half of the sulfur content of

coal normally produced for metallurgical applications was associated with pyrite at sizes suitable for separation in conventional equipment. Residual sulfur content was reasonably low (0.65 percent S), a residual value approached in samples from different sources in the Harbour Seam. Several methods of pyrite rejection and other technological procedures were considered. — *from* Authors' synopsis

Wanless, R. K. *See* Boyle, R. W. 05076

Ward, Stanley H. *See* Hohmann, Gerald W. 04785

04572 **Wardlaw, N. C.** Effects of fusion, rates of crystallization and leaching on bromide and rubidium solid solutions in halite, sylvite and carnallite, *in* Third symposium on salt, V. 1 (J. L. Rau and L. F. Dellwig, editors): Cleveland, Ohio, Northern Ohio Geol. Soc., p. 223-231, illus., tables, 1970.

Controlled experiments at room temperatures, to determine the Rb and Br in artificial sylvite derived from carnallite, were conducted. The MgCl was leached by pure water. The results do not correspond exactly with predictions based on published solubility data and partition coefficients. It was found that under otherwise similar conditions, sylvite crystallized slowly has only about 0.8 times the bromine of sylvite crystallized rapidly. Similarly, it is usually assumed that recrystallization of salts in the absence of a liquid phase will not result in changed trace element contents. This assumption is supported by the observation that fusion of halite and sylvite does not significantly change their contents of bromide. — *from* Author's abstract

Warman, James C. *See* Wilson, Gary V. 05068

04509 **Warren, Charles R.** Surficial geologic map of the Litchfield quadrangle, Litchfield County, Connecticut: U.S. Geol. Survey Geol. Quad. Map GQ-848, scale 1:24,000, text, 1970.

The text summarizes the preglacial topography, glacial erosion, till deposition, and glaciofulvial and postglacial changes in the Litchfield quadrangle. — MCM

04605 **Wasson, John T.** Ni, Ga, Ge and Ir in the metal of iron-meteorites-with-silicate-inclusions: Geochim. et Cosmochim. Acta, v. 34, no. 9, p. 957-964, illus., table, 1970.

Neutron-activation determined concentrations of Ni, Ga, Ge, and Ir on the metal of 19 iron-meteorites-with-silicate-inclusions are in good agreement with the classification of Bunch, Keil, and Olsen, which is based mainly on the mineralogy and texture of the inclusions. Odessa-type and Copiapo-type irons-with-silicate-inclusions are found to be very closely related to each other, and to other members of chemical group I of the iron meteorites. Kendall County is probably related to these irons. Elga is a new Weekeroo Station-type iron-with-silicate-inclusion, and Netschaevo is closely related to these objects. Tucson is unique. Odessa-type and Copiapo-type meteorites appear to have formed nonigneously, whereas shock mixing and associated differentiation of silicates appears to have been a late step in the history of the Weekeroo Station-type irons. — Author's abstract

Waters, Aaron C. *See* Higgins, Michael W. 04463

04636 **Watkins, F. A., Jr.; Heisel, J. E.** Electrical-analog-model study of water resources of the Columbus area, Bartholomew County, Indiana: U.S. Geol. Survey Water-Supply Paper 1981, 22 p., illus., tables, 1970.

The Columbus study area is in part of a glacial outwash sand and gravel aquifer deposited in a preglacial bedrock valley; ground water is unconfined. Average horizontal permeability for the aquifer is about 3,500 gpd/sq ft; transmissibilities range from near zero in some places along the boundary to about 500,000 gpd/ft in the thicker parts. About 800,000 acre-feet of water is in storage, equivalent to an average yield of 34 mgd for about 21 years without recharge. Analyses of the electrical-analog-model built to analyze the aquifer system and determine effects of development indicates more than enough water to meet estimated needs of the city

of Columbus without seriously depleting the aquifer. Decline in water levels as predicted by the model for 1970-2015 ranged from about 20 feet in the center of pumping areas to 3 feet or less in areas upstream or downstream. — *from* Authors' abstract

Watson, D. E. *See* Kellogg, Karl. 04799

Webb, J. S. *See* Nichol, Ian. 04870

Weill, Daniel F. *See* Bottinga, Y. 04659

04867 **Weissberg, B. C.** Solubility of gold in hydrothermal alkaline sulfide solutions: Econ. Geology, v. 65, no. 5, p. 551-556, illus., 1970.

Solubility of gold experimentally determined at elevated temperatures in alkaline Na_2S solutions ranges from 1 to 6 ppm Au in solutions with 0.25 to 0.9 moles Na_2S/kg solution at temperatures between 150 and 290°C. In less alkaline solutions, where the HS^- ion predominates, experimentally determined solubility of gold ranges from 100 to 200 ppm Au in solutions containing from 0.2 to 0.3 moles NaHS/kg solution at between 150 and 250°C. Calculations indicate that gold solubility due to formation of a gold sulfide complex tentatively formulated as AuS^- is more than adequate to account for transport of gold in some natural near-neutral low salinity hydrothermal solutions, such as in Broadlands-Ohaki and Waiotapu areas, New Zealand, where currently forming surface precipitates contain up to 85 ppm Au. This makes a postulated near-neutral gold sulfide transport mechanism a particularly effective means for formation of epithermal gold deposits. — *from* Author's abstract

Weissenborn, A. E. *See* Society of Economic Geologists. 04909

04723 **Welles, S. P.** *Dilophosaurus* (Reptilia: Saurischia), a new name for a dinosaur: Jour. Paleontology, v. 44, no. 5, p. 989, 1970.

Megalosaurus wetherilli Welles, 1954 was originally described from the Jurassic Kayenta Formation near Tuba City, Ariz. Later discovery of a larger, adult specimen of the same species, near the type locality, has enabled restudy and restoration of the juvenile type specimen. It is now apparent that the reptile does not belong in the carnosaur genus *Megalosaurus* but is the type of a new genus, which is placed in the family Coeluridae and for which the name *Dilophosaurus* is proposed. The species is the only known theropod with two high longitudinal crests on top of its skull. A detailed redescription will be published later. — VMJ

04738 **Wellman, Thomas R.** Fugacities and activity coefficients of NaCl in NaCl-H_2O fluids at elevated temperatures and pressures: Am. Jour. Sci., v. 269, no. 4, p. 402-413, illus., table, 1970.

Experimental data for coexisting synthetic nepheline, sodalite, and aqueous fluid have been used to calculate the fugacities and activity coefficients of NaCl in aqueous fluid as a function of temperature, pressure, and NaCl mole fraction in the range 500° to 700°C and 600 to 2000 bars fluid pressure. — Author's abstract

04709 **West, Robert M.** *Tetraclaenodon puercensis* (Mammalia: Phenacodontidae), Goler Formation, Paleocene of California, and distribution of the genus: Jour. Paleontology, v. 44, no. 5, p. 851-857, illus., 1970.

The discovery of one specimen of *Tetraclaenodon puercensis* adds a fourth mammalian genus to the Laudate local fauna from the Goler Formation, Kern County, Calif., substantiating earlier estimates of a middle Paleocene age for at least part of the unit. Presence of this species in the Goler also suggests that there was faunal movement between the Rocky Mountain area and the west coast. Despite the wide geographic range of *Tetraclaenodon*-producing localities, their distribution hinders adequate paleogeographic interpretations of Paleocene faunal realms. Application has been made to the International Commission on Zoological Nomenclature to suppress generic name *Protogonia* and to declare the valid name. — *from* Author's abstract

04586 **Westine, P. S.** Explosive cratering [with French and German abs.]: Jour. Terramechanics, v. 7, no. 2, p. 9-19, illus., table, 1970.

The paper presents a graphical solution for apparent crater radius, depth and volume from a knowledge of explosive charge weight, depth of burial and soil properties. Experimental data demonstrates that the solution applies over a wide range of conditions including sand, clay and rock. — Author's summary

04677 **Wetzel, Robert G.** Recent and postglacial production rates of a marl lake: Limnology and Oceanography, v. 15, no. 4, p. 491-503, illus., 1970.

Pigment degradation products were analyzed spectrophotometrically in postglacial C-14 dated sediment cores from the central depression and a littoral marl lakemount of Pretty Lake in northeastern Indiana. There was a major peak of pigment products per gram of organic matter at about 9,500 B.P., following the Boreal period; subsequent regression of productivity with lesser peaks, especially during 6,500-5,500 B.P.; and a slow increase in recent times. Contemporary rates of primary production were extrapolated to the inception of the lake, about 13,500 B.P. Chlorophyll degradation products per unit organic content generally were inversely related to carbonate levels. Sedimentation rates in the central depression accelerated gradually, while those at the lakemount fluctuated sigmoidally, greatly accelerating during 9,000-7,000 B.P. and ceasing at 2,740 B.P. The probable ontogeny of lakemounts is discussed. — *from* Author's abstract

04933 **Weyl, Richard.** Mittelamerika — Krustenbau und paläogeographische Entwicklung [Central America — Crustal structure and paleogeographic history]: Umschau, v. 70, no. 10, p. 295-299, illus., 1970.

In terms of structure and geologic history, the northern part of Central America is related to the North American continent; the southern part represents an extension of the South American Andes. In the north, the basement is typical continental crust; the southern part is underlain by oceanic crust. Successive stages of uplift, transgression of the sea, and volcanism since the end of the Cretaceous in the south and since the middle Paleozoic in the north are briefly outlined. Sketch maps show the distribution of land masses, islands, and marine basins in Jurassic and later epochs. — MS

04968 **Weyl, Richard.** Geologische Bilder aus Mittelamerika — [Pt.] 3, An der pazifischen Flachlandküste von Costa Rica [Geologic illustrations from Central America — (Pt.) 3, On the Pacific lowland coast of Costa Rica]: Natur u. Mus., v. 100, no. 3, p. 120-128, illus., 1970.

The author describes in general terms the landforms of the Pacific lowland coast of Costa Rica near Puntarenas and the mountainous country inland from Quepos, which consists of basalts and sediments of the Nicoya complex in the western part and of sandstones, siltstones, and upper Eocene limestones in the east. Eocene formations are oriented north-south, paralleling the Pacific coast. — EH

04969 **Weyl, Richard.** Geologische Bilder aus Mittelamerika — [Pt.] 5, In den Ignimbritplateaus von Honduras und Nicaragua [Geologic illustrations from Central America — (Pt.) 5, In the ignimbrite plateaus of Honduras and Nicaragua]: Natur u. Mus., v. 100, no. 8, p. 362-370, illus., 1970.

The pink and green tuff used as a building stone in Tegucigalpa, is a typical ignimbrite, occurring in columnar form in quarries outside the city and constituting the predominant rock in central Honduras. Plateaus of ignimbrite cover large areas of Honduras and Nicaragua. Samples have been dated by the K-Ar method as 17 m.y. The author reviews ideas of the origin of these volcanic rocks. — EH

05067 **Weyl, Richard.** Geologische Bilder aus Mittelamerika — [Pt.] 4, Die Vulkane der Cordillera de Guanacaste und ihr Vorfeld [Geologic illustrations from Central America — (Pt.) 4, The volcanoes of the Cordillera de Guanacaste and their base areas]: Natur u. Mus., v. 100, no. 6, p. 269-278, illus., 1970.

This study of the volcanoes of the Cordillera de Guanacaste in northern Costa Rica discusses the eruption of Arenal Volcano in 1968, during which a cloud of hot ashes, similar to that produced by Mt. Pelée, and lava flows covered a large area. Much stronger and hotter eruptions must have occurred in Quaternary times to have formed the 50-km-long Meseta Volcanica de Santa Rosa, a tuff plateau southwest of the Cordillera de Guanacaste. It contains the lower, Bagaces Formation of ignimbrites and porous ash-cloud deposits containing obsidian-like particles, and the smaller Liberia Formation at the foot of Rincón de la Vieja Volcano, whose pumaceous tuffs have a high silica content and are similar to rhyodacites. — EH

Whalley, B. J. P. *See* Walsh, J. H. 04561

Wheeler, E. F. *See* Bartholomew, R. L. 04609

04661 **Whitcomb, James H.; Anderson, Don L.** Reflection of P'P' seismic waves from discontinuities in the mantle: Jour. Geophys. Research, v. 75, no. 29, p. 5713-5728, illus., tables, 1970.

A systematic study of traveltimes and apparent velocities of precursors of the seismic core phase PKPPKP indicate that these phases are mantle reflections. The strongest reflection is from 639 km; others were found at depths of 280, 520, 940, 410 (very weak), and 1250 km (tentative). The surprising weakness of the 410-km reflection suggests that this transition region must be broader than others or must involve a smaller density jump. Possible reflections from top and bottom of the low-velocity zone at 50 and 130 km, respectively, were observed. Results are interpreted in terms of the following solid-solid phase changes, in order of increasing depth: pyroxene-garnet solid solution, olivine to β spinel, β spinel to spinel and pyroxene to spinel + stishovite, spinel to post-spinel, and garnet to ilmenite or oxides. A spin-spin transition in Fe^{2+} may be responsible for one of deeper discontinuities found by others. — DBV

Whitham, K. *See* Niblett, E. R. 04501

Wiggins, Jack L. *See* Damon, Norman. 04493

Wignall, T. K. *See* DeGeoffroy, J. 04480

Wilcoxon, James A. *See* Bandy, Orville L. 04874

04792 **Wilhelmy, H.** Gestalt eines Grossen — Alexander von Humboldt in der Sicht seiner amerikanischen Reise [One phase of a great man — Alexander von Humboldt in light of his American journeys], *in* Alexander von Humboldt, eigene und neue Wertungen der Reisen, Arbeit und Gedankenwelt — Erdkundliches Wissen, Heft 23: Wiesbaden, Germany, Franz Steiner Verlag GMBH, p. 1-22, 1970.

Williams, Ray. *See* Douglas, Bruce M. 04685

05068 **Wilson, Gary V.; Joiner, Thomas J.; Warman, James C.** Evaluation, by test drilling, of geophysical methods used for ground-water development in the Piedmont area, Alabama: Alabama Geol. Survey Circ. 65, 15 p., illus., table, 1970.

Eleven test wells were drilled in the vicinity of Heflin in Cleburne County, Alabama, to evaluate the interpretations and concepts developed in earlier geophysical studies conducted in 1966 and 1967. Quantities of ground water adequate for municipal and industrial purposes were not found. Geological interpretations based on geophysical data were proved to be essentially accurate. Geophysical methods, techniques, and concepts evaluated during this research will be of value to future studies in Piedmont areas. — Authors' abstract

04845 **Wilson, J. L.** North Slope potential and effect on domestic exploration in the seventies [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1793, 1970.

05044 **Wilson, J. Tuzo.** Science of the earth, [Chap.] 12 *in* The megatectonics of continents and oceans (Helgi Johnson and Bennett L. Smith, editors): New Brunswick, N. J., Rutgers Univ. Press, p. 253-268, 1970.

If the thesis is true that continents, in some parts relatively old, are forever growing and accumulating with dominant structures compressed in zones parallel with their margins, and that ocean floors are relatively young and forever upwelling with dominant structures tensional along the mid-ocean ridges, then all textbooks on general and historical geology are out of date, and those on structural geology will require a chapter about the different tectonic behavior of ocean floors. Earth science may be at a turning point, and such unrelated subjects as mineralogy, paleontology, geomagnetics, seismology, and the like should be combined into one science of the Earth. — VSN

04846 **Wilson, James Lee.** Depositional facies across carbonate shelf margins [abs.]: Am. Assoc. Petroleum Geologists, v. 54, no. 9, p. 1793, 1970.

04750 **Wilson, Leonard G.** Sir Charles Lyell's scientific journals on the species question: New Haven, Conn., and London, England, Yale Univ. Press, 572 p., illus., 1970.

Wilson, Richard L. *See* Cavender, Ted M. 04630

04947 **Windom, Herbert L.** Atmospheric dust records in permanent snowfields, implications to marine sedimentation — Reply [to discussion of 1969 paper by W. L. Hamilton, 1970]: Geol. Soc. America Bull., v. 81, no. 10, p. 3177, 1970.

For original paper, *see* ibid., v. 80, no. 5, p. 761-782, 1969; Abs. North American Geology, September 1969. For discussion by Hamilton, *see* ibid., v. 81, no. 10, p. 3175-3176, 1970.

Winslow, A. G. *See* Turcan, A. N., Jr. 04803

04812 **Wissler, Stanley G.** Earl Bart Noble (1894-1970): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 9, p. 1755-1757, portrait, 1970.

Witherspoon, Paul A. *See* Neuman, Shlomo P. 05056

05010 **Wold, R. J.; Woodzick, T. L.; Ostenso, N. A.** Structure of the Beaufort Sea continental margins: Geophysics, v. 35, no. 5, p. 849-861, illus., 1970.

Data from a 1968 airborne gravity survey in the Beaufort Sea were combined with data from previous surveys. The major feature of the free-air anomaly map is a more or less continuous 100-mgal high paralleling the coast which is explained by thinning of the crust and a ridge in the basement at about the 200-m isobath. This linear anomaly is broken by saddles which reflect sedimentary fans built by the Colville, Mackenzie, and Barnard Rivers. Two-dimensional crustal models indicate a narrow transition zone from oceanic to continental crustal thickness, 55 km to 100 km shoreward of the 2,000-m isobath; Worzel (1968) found this transition zone to be centered under the 2,000-m isobath. The departure from "normal" in this area may be due to a greater accumulation of sediments seaward of the "structural" continental margins, which implies faster sedimentation and(or) greater age for the Beaufort Sea continental margins. — DBV

Woodzick, T. L. *See* Wold, R. J. 05010

Worstell, Paula. *See* Eicher, Don L. 04705

04958 **Worthington, Joseph E.; Kiff, Irving T.** A suggested volcanigenic origin for certain gold deposits in the slate belt of the North Carolina Piedmont: Econ. Geology, v. 65, no. 5, p. 529-537, illus., 1970.

Lode gold deposits in the south-central Piedmont of North Carolina commonly are zones of silicified and weakly pyritic strata bearing low-grade gold ore. Deposits are

largely conformable and are almost entirely within the basal volcanic unit or a short distance stratigraphically above it. In as much as the area has no prominent granite intrusives, is only weakly metamorphosed and has only minor evidences of subsequent hydrothermal mineralization, the strata-bound gold lodes seemingly must be referred to their enclosing volcanic strata for their origin. A volcanigenic origin for the gold deposits in the waning exhalations of the basal felsic volcanic pile seems to best account for the form, composition, and areal distribution of these deposits. Such an origin has certain similarities to many epithermal precious-metal deposits in more recent volcanic fields in western United States. — *from* Authors' abstract

Wright, W. B. *See* Cohee, G. V. 04694

04911 **Yates, Robert G.** Geologic background of the Metaline and Northport mining districts, Washington, [Chap.] 3 *in* Lead-zinc deposits in the Kootenay Arc, northeastern Washington and adjacent British Columbia — Soc. Econ. Geologists, 1970 Northwest Field Conf. Guidebook: Washington Div. Mines and Geology Bull. 61, p. 17-39, illus., 1970.

Almost all lead-zinc deposits in northeastern Washington are replacements in Cambrian carbonate rocks. The depositional history of the Precambrian-Tertiary strata is reviewed, and a correlation table is given for the Metaline and Northport districts of Washington, and the Salmo district in British Columbia. Tectonic events influenced and controlled the facies and distribution, including decollement thrusting in the Devonian-Jurassic interval, a disturbance in the Triassic, and a great folding in Late Jurassic or Early Cretaceous. On the basis of these events, the geology is interpreted in terms of features on a map. All pre-Cretaceous rocks were exposed to a regional greenschist facies metamorphism at the time of northeast folding. Contact metamorphic aureoles extend out two miles from the Kaniksu batholith and Spirit pluton. The ore deposits can be placed stratigraphically, but the time and process of mineralization are not certain. — ESL

04795 **Youngblood, Irma; Koehn, Henry H.** (compilers). Theses and dissertations of the New Mexico Institute of Mining and Technology, 1931-1969: New Mexico Bur. Mines and Mineral Resources Circ. 107, 20 p., 1970.

Citations are arranged alphabetically by author with subject field indicated; a subject index is included. — MCM

05089 **Younkin, Robert L.** Optical reflectance of local areas of the Moon: Astron. Jour., v. 75, no. 7, p. 831-841, illus., tables, 1970.

Photoelectric measurements of solar energy from 0.31 to 1.1μ reflected from the lunar crater Plato, made in Mount Wilson Observatory, are reported. The following conclusions can be drawn: (1) In general, the redder the mare, the more the iron. (2) The highlands show variations in iron content but not in color. (3) In general, the maria contain more iron than the highlands, which is consistent with the two Surveyor samples. (4) Of the "non-blue" bright craters, Proclus in the highlands is similar to the highland group and Kepler in a mare is similar to the maria group. Oceanus Procellarum I is anomalously rich in iron. (5) Three "blue" bright craters, anomalous in color, bear no discernible relationship to their surrounding areas. They are quite similar in iron content. — DBV

Zamarský, Vítězslav. *See* Kudělasek, Vladimír. 04537

Zelinskaya, M. R. *See* Troitskiy, V. S. 05096

05125 **Zietz, Isidore; Kirby, John R.** Aeromagnetic map of Minnesota: U.S. Geol. Survey Geophys. Inv. Map GP-725, scale 1:1,000,000, 1970.

05045 **Zimmerman, Paul A.** (editor). Rock strata and the Bible record: St. Louis, Mo., and London, England, Concordia Publishing House, 209 p., illus., tables, 1970.

The chapters in the book were written as a summary of discussion by a committee of scientists and theologians, and of important information dealing with topics assigned to a symposium, all sponsored by the Lutheran Church, Missouri Synod. Papers by the scientists are cited separately. — MCM

Zlatkis, A. *See* Oro, J. 05088

05126 **Zohdy, Adel A. R.** Variable azimuth Schlumberger resistivity sounding and profiling near a vertical contact: U.S. Geol. Survey Bull. 1313-A, p. A1-A22, illus., 1970.

Two formulas are derived for computing theoretical sounding curves of Schlumberger type near a vertical contact; curves indicate that for a given angle γ, the form of a curve changes more as a function of μ for $\mu < 1$ than for $\mu > 1$. For values of μ $0 > 20$, curves for a given value of γ are almost identical; for values of $\mu \ll 1$, theoretical curves are significantly distinct from one another when γ is varied. Results of computations were used to draw sounding curves at certain azimuth angles and construct circular sounding diagrams and resistivity profiles. The form of resistivity hodographs obtained differ in shape depending on whether the array center is placed on the conductive or resistive medium. Because of complexity when the array center is placed over a resistive medium, the exact form of most hodographs can be realized only from three or more soundings for different azimuths. — *from* Author's summary

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